SUGARCANE RESEARCH

Annual Progress Report

1990

LOUISIANA
AGRICULTURAL
EXPERIMENT STATION
LOUISIANA STATE UNIVERSITY AGRICULTURAL CENTER

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ANNUAL PROGRESS REPORT

1990

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LOUISIANA AGRICULTURAL EXPERIMENT STATION
DR. KENNETH W. TIPTON
VICE CHANCELLOR AND DIRECTOR

LOUISIANA STATE UNIVERSITY AGRICULTURAL CENTER
DR. H. ROUSE CAFFEY, CHANCELLOR

FOREWORD

Research on sugarcane in the Louisiana Agricultural Experiment Station is an integral part of the LSU Agricultural Center's research-extension effort to provide the knowledge and technology base for efficient production and processing of sugarcane. Sugarcane research projects are led by scientists in the Sugar Station/Audubon Sugar Institute, and the departments of: Agricultural Economics and Agribusiness, Agricultural Engineering, Agronomy, Entomology, and Plant Pathology and Crop Physiology.

Members of the Louisiana Agricultural Experiment Station maintain close working relations with colleagues in respective departments of the College of Agriculture and other colleges of the LSU Baton Rouge campus, the Louisiana Cooperative Extension Service, the Agricultural Research Service and Soil Conservation Service of the USDA, the American Sugar Cane League, and the Louisiana Department of Agriculture.

A major portion of the resources for production and processing research are linked to the St. Gabriel Station and Sugar Station/Audubon Sugar Institute respectively. The Iberia Research Station helped to accomplish specific sugarcane research objectives in 1990.

Important parts of the 1990 research effort were conducted on cooperating farms and in cooperating factories throughout the industry. The dwindling of the farm labor supply has been making the evaluation of location effects and location interaction effects increasingly difficult. However, these evaluations are very important and must be continued. The cooperation of individual farms and sugarcane factories in conducting research projects and financial support of the American Sugar Cane League is gratefully acknowledged.

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Louisiana Agricultural Experiment Station
Louisiana State University Agricultural Center
Baton Rouge, Louisiana

and

United States Department of Agriculture
Agricultural Research Service
Washington, D.C.

and

American Sugar Cane League of the U.S.A., Inc.
Thibodaux, Louisiana

Notice of Release of Sugarcane Variety LCP 82-89

The Louisiana Agricultural Experiment Station of the Louisiana State University Agricultural Center, the Agricultural Research Service of the United States Department of Agriculture and the American Sugar Cane League of the U.S.A., Inc., working cooperatively to improve sugarcane varieties, have jointly developed and hereby announce the release of a new variety, **LCP 82-89**, for commercial planting in the fall of 1990.

LCP 82-89 is a product of the cross CP 52-68 X CP 72-370. LCP 82-89 is a high yielding, good stubbling variety that produces a high population of medium size stalks. Data from 77 mechanically harvested outfield trials on both silt loam and clay soils indicate that LCP 82-89 is superior to CP 70-321 in yield of sugar and cane per acre in plant and stubble crops. LCP 82-89 is similar to CP 70-321 in sugar per ton and maturity, with a fiber content and normal juice extraction intermediate between CP 70-321 and CP 65-357. The variety has been assigned a mill factor of 1.021. With harvesting characteristics similar to CP 65-357 and CP 74-383, LCP 82-89 is well suited to mechanical harvesting.

The variety is moderately susceptible to the spread of sugarcane mosaic virus in the field. The effect of ratoon stunting disease on LCP 82-89 is unknown at this time. LCP 82-89 is considered resistant to smut (caused by Ustilago scitaminea Syd.) and appears resistant to rust (caused by Puccinia melanocephala H & P Syd.) under Louisiana field conditions. LCP 82-89 is resistant to the sugarcane borer [Diatraea saccharalis (F.)]. Preliminary data suggest LCP 82-89 may be susceptible to injury by some herbicides.

Seed cane will be distributed by the American Sugar Cane League. Inquiries concerning seed cane should be directed to the American Sugar Cane League, 206 E Bayou Rd., Thibodaux, LA 70301. The Louisiana Agricultural Experiment Station and the U.S. Department of Agriculture do not have seed cane available for distribution.

Each agency will make such news release as considered appropriate.

K. W. Tipton — 6/5/90
Director, Louisiana Agricultural Experiment Station — Date

[signature] — JUN 2 8 1990
Administrator, Agricultural Research Service — Date

[signature] — 06/29/90
President, American Sugar Cane League of the U.S.A., Inc. — Date

AN OVERVIEW OF THE LOUISIANA "L" SUGARCANE VARIETY DEVELOPMENT PROGRAM

F. A. Martin
Sugar Station/Audubon Sugar Institute

The release of the sugarcane variety LCP 82-89 on May 17, 1990, was a milestone for the LAES Sugarcane Breeding and Variety Development Program. This event was the culmination of the recognition of program progress that had been made over the past decade. Due to the biomass of the plant, sugarcane research is physically demanding. Significant genetic interactions with years and locations dictates that meaningful sugarcane breeding and variety genotype decisions must be based on data from several years and locations. Couple the above with limited resources for research, and it becomes clear that progress can only be achieved if personnel work as a team. Although he has a specific area of responsibility, each team member has a general understanding of the entire program and often is called upon to assist in other areas of the program. Current team members (Table 1) contribute expertise in the areas of agronomy, breeding, genetics, statistics, entomology, pathology, weed science and physiology.

Table 1. Members of the LAES Sugarcane Breeding and Variety Development Team.

Team Member	Budgetary Unit	Responsibility
F. A. Martin	Agronomy/Sugar Station/ASI	Program Leader
J. P. Quebedeaux	Agronomy	Photoperiod & Crossing
K. B. Bischoff	Agronomy	Selection
S. B. Milligan	Agronomy	Quantitative Genetics
A. M. Saxton	Experimental Statistics	Statistical Genetics
W. A. Millet	Sugar Station/ASI	Sucrose Laboratory
C. J. Ramagos	St. Gabriel Station	Farm Manager
H. P. Schexnayder	St. Gabriel Station	Variety Testing
H. P. Viator	Iberia Station	Variety Testing
K. L. Quebedeaux	Iberia Station	Variety Testing
T. E. Reagan	Entomology	Insect Resistance Testing
J. W. Hoy	Plant Pathology & Crop Physiology	Disease Resistance Testing
J. L. Griffin	Plant Pathology & Crop Physiology	Herbicide Tolerance

People who contributed to the "L" program and have since left university employment include: Mr. E. Dufrene, Mr. J. Berg, Miss V. Taylor, Dr. M. Giamalva, Mr. D. Lester, Mr. D. Fontenot, Mr. E. LeBlanc, and Mr. G. Dimarco.

The "L" Sugarcane Breeding and Variety Development Program would not be possible without the support of the Director of the Louisiana Agricultural Experiment Station and the financial support of the American Sugar Cane League.

The LAES sugarcane breeding team and the USDA sugarcane breeding team work independently yet cooperatively to produce "L" and "CP" varieties respectively. The best varieties from the two programs are evaluated collaboratively at "outfield test locations" by personnel of the Louisiana Agricultural Experiment Station; the United States Department of Agriculture; and the American Sugar Cane League in accordance to the provisions of the "Three-way agreement of 1978". After twelve years of testing, those varieties that show promise are released for commercial production.

Although the overall structure of the program and the working relationships with the USDA and ASCL has not changed there have been changes in approach that may be worth documenting.

Overall Philosophy: With full realization that the Louisiana sugarcane industry needs new varieties from our program, our primary concern is to identify the elite varieties from each year's group of seedlings and return them to the crossing program as soon as possible. This will insure maximum genetic advance of the "L" sugarcane breeding population. With the realization that germplasm development is a primary mission of the USDA/ARS, we rely on the basic and introgression programs at Houma, La. and Canal Point, FL for new genetic material to insure genetic diversity in our program. Graduate student research projects are carried out in the context of the breeding program. Accordingly, findings of these research projects are used to improve the program.

Traits Emphasized: Review of economic analysis of sugarcane production in Louisiana indicate that two major costs areas are planting and harvesting. Varieties can contribute to minimizing these costs if they stubble well and are well suited for mechanical harvesting. In the early 1980's we decided to place special emphasis on these traits.

Photoperiod & Crossing: The facilities built at St. Gabriel in 1982 gave new opportunities to the program. Through careful record keeping and analysis we discovered that each variety responds uniquely to photoperiod treatment. By setting a target date of flowering and starting photoperiod treatment for each variety based on previous response to photoperiod treatment, we were able to achieve uniformity in flowering dates. This approach was so successful that it taxed our crossing greenhouse capacity. We have since fine-tuned the approach to produce two flowering peaks (late September and mid October).

Selection & Testing: In the early 1980's we decided to use the sandy and clay soils on the St. Gabriel Station to screen against varieties that are suitable for only a narrow range of soil types. As each new series goes through the program we alternate the plantings on sandy and clay soils to identify the generally adapted varieties. In 1985, the Iberia Station joined in our variety testing effort. Currently, new assignments are tested at the St. Gabriel Station (two soil types), the Iberia Station and two off-station locations before they are introduced to the outfield locations for final testing. In order to have enough seed for the above, we initiated the planting of a seed increase plot during the plant cane year of the second line trial year. With experience we learned that the increase plots could be used as another evaluation stage. As we realized that there was potential to reduce the number of years in the program, we reorganized duty assignments of two variety testing research

associates in 1990. Rather than continuing with the concept of "infield" and "outfield" associates, we divided the responsibility by geography divided by the Atchafalaya Basin.

Entomology Testing: Through the cooperative efforts of Dr. T. E. Reagan we moved the beginning of testing for borer resistance from the "outfield test" stage to the year after assignment. The intention was to know the borer resistance levels of the elite varieties before we began using them in the crossing program.

Pathology Testing: The appearance of sugarcane smut in Louisiana in the early 1980's increased the demands on sugarcane breeding. Dr. Jeff Hoy of the Plant Pathology and Crop Physiology Department conducts the variety evaluations for sugarcane smut and sugarcane mosaic. Inoculation trials to evaluate smut resistance begin the year of assignment. Mosaic resistance evaluations are conducted at the outfield locations.

Herbicide Testing: Dr. Jim Griffin is cooperating to evaluate sugarcane variety tolerance to commonly used herbicides. This research will provide needed information to complete the characterization of new varieties for breeding and for commercial production.

Future: As we look to the future, the Louisiana Sugarcane Variety Development Team has several challenges and/or opportunities to accelerate the rate of improving sugarcane varieties. One challenge is to continue to explore and incorporate methods to identify elite genotypes as early as possible. This will certainly involve screening new material across different environments early in the program. A second challenge is to develop rapid methods to identify and exploit superior crosses. Family testing for yield components is currently being studied. The third is to work with biotechnologists and incorporate new techniques as soon as they become practical.

If we meet these challenges, we will develop the "L" Sugarcane Variety Development Program so it will consistently produce sugarcane varieties that provide new opportunities for the Louisiana sugarcane industry.

PHOTOPERIOD AND CROSSING IN THE LOUISIANA "L" SUGARCANE VARIETY DEVELOPMENT PROGRAM FOR THE YEAR 1990

Joey P. Quebedeaux and F. A. Martin
Department of Agronomy

Summary

All subsequent stages of the Louisiana "L" Sugarcane Variety Development Program rely upon the production of viable "true" seed from the crossing stage of the program.

Two-hundred eighteen varieties of sugarcane were used in the 1990 photoperiod campaign. There were 83 "L" varieties, 30 "LCP" varieties, 99 "CP" varieties selected for Louisiana, two "CP" varieties selected for Florida, and four "US" varieties. One-hundred four varieties were of unknown photoperiod response. To produce desirable crosses from a large number of sugarcane varieties, synchronization of tasseling is of utmost importance.

Objectives

1. To produce viable "true" seed for testing in the Louisiana "L" Sugarcane Variety Development Program.

2. Repeat the 1989 photoperiod strategy.

3. To synchronize the tasseling of the numerous varieties used in the crossing stage. To ease the congestion of tassels in the crossing greenhouse, the tasseling season was split into two peaks.

4. To obtain data on the tasseling response of experimental varieties introduced as parental material.

Results and Discussion

Sunlight was the sole light source for the 1990 photoperiod treatments. The doors of the photoperiod bays were opened at the prescribed time to start the photoperiod treatments and the carts were pulled from the photoperiod houses. The natural sunset terminated the photoperiod for each day. The carts were pushed into the photoperiod houses after sunset. All bays recieved induction cycles (constant daylength) of 12 hours and 30 minutes.

The number of induction cycles required to initiate tasseling, calculated from data gathered from previous crossing seasons, determined which day the photoperiod treatment was begun for a particular variety/bay/cart situation (Table 1). Varieties are grouped on the carts according to their ease of photoperiod induction. The start date for a particular cart is determined by the harder to induce varieties on that cart. Easier to induce varieties on that cart were removed prior to the start date and reinstalled at later dates.

Fifty-eight early to medium tasseling varieties were placed on the nine rail carts in Bays 1, 2, and 3. Varieties designated for pollination were placed on the carts in Bays 1 and 2. Varieties designated for pollen production were placed on the carts in Bays 2 and 3 and were heated when ambient temperature fell below 70°F. Results from previous experiments have shown that varieties protected from cool night temperatures tasseled earlier than unprotected varieties. Therefore, to synchronize tasseling, the decreasing of photoperiod for Bays 2 and 3 commenced five days later than that for Bay 1.

Ninety-five early to late tasseling varieties were placed on the nine rail carts in Bays 4, 5, and 6. Varieties designated for pollen production were placed on the carts in Bays 4 and 5 and were heated when ambient temperature fell below 70°F. Previous experiments suggested that decreasing the photoperiod at a slower rate produces more viable pollen. Therefore, to synchronize tasseling, the photoperiod decrease for Bay 4 (which contained only pollen producing varieties and decreased at a slower rate than Bay 5) was begun 10 days earlier than Bay 5. Varieties designated for pollination were placed on the carts in Bays 5 and 6. Bay 6, containing most of the newer varieties to the crossing program which did not present much flowering data, was heated until tassels began to emerge and then was left unprotected from cool nights. To synchronize tasseling, the photoperiod decrease for Bay 6 (which decreased at the same rate as Bay 5) was begun five days earlier than Bay 5.

To delay tasseling later than what was experienced in 1989, the decline dates for all bays were pushed back five days. Synchronization of tasseling between the two peaks and across all six bays was excellent, with the exception of a few of the newer varieties that were hard to induce. Tasseling results are summarized in Table 2. Crossing began on September 20 and ended on November 13. Three hundred fifty-four crosses were made during the 1990 crossing campaign and are summarized in Tables 3, 4, 5, and 6.

The 104 varieties of unknown photoperiod response, along with 12 varieties of known photoperiod response ranging from early to late, were placed on the greenhouse rail cart system for natural induction. Anthesis began on November 29 and continued until the beginning of January. At this point, all varieties that had not tasseled were examined for signs of induction. By comparing the date of tasseling to those of the known varieties, a first approximation of the photoperiod response of the new varieties was made. The pollen producing capacity of each new variety that tasseled after natural induction was also estimated. Because of the successful synchronization and crossing of the photoperiod house induced tassels and the need to economize expenses, no crosses were made with the tassels induced by natural photoperiod.

Table 1. Summary of the 1990 photoperiod treatments.

Bay	Cart	Start Treatment	Decline Date	Decline Rate[1/]	Heat Status	Target Tasseling Date
1	A	June 29	July 10	1	No	Sept 27
1	B	June 19	" "	1	No	" "
1	C	June 11	" "	1	No	" "
2	A	July 09	July 15	1	Yes	" "
2	B	June 21	" "	1	Yes	" "
2	C	June 14	" "	1	Yes	" "
3	A	June 29	July 15	1	Yes	" "
3	B	June 16	" "	1	Yes	" "
3	C	June 05	" "	1	Yes	" "
4	A	July 03	July 19	1/2	Yes	Oct 11
4	B	June 18	" "	1/2	Yes	" "
4	C	June 06	" "	1/2	Yes	" "
5	A	June 27	July 29	1	Yes	" "
5	B	June 05	" "	1	Yes	" "
5	C	June 05	" "	1	Yes	" "
6	A	June 18	July 24	1	Yes	" "
6	B	June 05	" "	1	Yes	" "
6	C	June 05	" "	1	Yes	" "

[1/] Minutes per day.

Table 2. Minimum days to first flower by photoperiod treatment for 1990[1].

Variety	Early Heat 1 Min	Early No Heat 1 Min	Late Heat 1 Min	Late Heat 0.5 Min	Heat Natural
CP65-357	281	274	290	.	INDC[2]
CP70-321	302	283	288	.	.
CP70-330	276	276	292	.	NONE
CP72-2086	NONE	.	.	INDC	.
CP72-356	.	.	.	.	NONE
CP72-370	323	281	288	.	.
CP73-343	295	.	.	313	.
CP73-351	.	.	.	.	NONE
CP74-383	274	290	292	302	INDC
CP75-1082	290	.	.	290	.
CP75-308	.	.	.	299	.
CP75-361	276	283	292	.	NONE
CP76-301	NONE	.	NONE	NONE	.
CP76-331	269	267	.	281	.
CP76-351	278	.	295	.	.
CP77-310	281	288	.	292	362
CP77-405	274	274	.	290	.
CP77-407	274	278	.	302	INDC
CP78-317	278	274	.	290	.
CP78-357	304	306	.	310	.
CP79-318	276	276	.	304	355
CP80-323	295	INDC	.	306	NONE
CP80-329	306	.	302	EMGD	.
CP82-550	281	.	295	.	.
CP82-551	.	.	INDC	.	NONE
CP83-644	302	INDC	.	.	.
CP84-730	INDC	NONE	EMGD	.	.
CP85-803	304	295	320	.	.
CP85-830	.	.	269	.	.
CP85-845	.	.	288	.	.
CP86-912	.	.	278	.	.
CP86-915	281	.	.	.	.
CP86-916	.	.	276	.	.
CP86-917	302	.	.	310	.
CP86-933	.	.	288	.	.
CP86-961	.	.	INDC	.	.
CP86-974	278	.	302	.	.
CP86-979	.	.	NONE	.	.
CP87-609	.	.	295	.	.
CP87-615	271	.	.	.	.
CP87-618	.	.	276	.	.
CP87-619	276	.	.	.	.
CP87-625	274	.	.	.	.
CP87-626	.	.	274	.	.
CP87-637	.	.	306	.	.
CP87-638	.	.	290	.	.
CP87-639	.	.	NONE	.	.
CP87-644	.	.	297	.	.
CP87-648	.	.	EMGD	.	.
CP87-649	.	.	283	.	.
CP87-650	.	.	274	.	.
CP87-652	.	.	BOOT	.	.
CP87-653	.	.	NONE	.	.
CP87-656	.	.	NONE	.	.
CP87-657	.	.	295	.	.
CP87-658	.	.	NONE	.	.
CP87-662	271	.	.	.	.
CP87-663	.	.	NONE	.	.

Table 2. Continued.

Variety	Early Heat 1 Min	Early No Heat 1 Min	Late Heat 1 Min	Late Heat 0.5 Min	Heat Natural
CP87-664	.	.	ABRT	.	.
CP87-665	.	.	295	.	.
CP87-666	.	.	NONE	.	.
CP87-667	.	.	266	.	.
CP87-668	.	.	297	.	.
CP88-701	.	.	.	.	EMGD
CP88-702	.	.	.	.	369
CP88-715	.	.	.	.	EMGD
CP88-717	.	.	.	.	NONE
CP88-718	.	.	.	.	367
CP88-725	.	.	.	.	NONE
CP88-729	.	.	.	.	NONE
CP88-730	.	.	.	.	338
CP88-731	.	.	.	.	NONE
CP88-736	.	.	.	.	348
CP88-739	.	.	.	.	NONE
CP88-741	.	.	.	.	NONE
CP88-742	.	.	.	.	333
CP88-744	.	.	.	.	365
CP88-748	.	.	.	.	INDC
CP88-749	.	.	.	.	NONE
CP88-751	.	.	.	.	NONE
CP88-753	.	.	.	.	NONE
CP88-754	.	.	.	.	NONE
CP88-755	.	.	.	.	348
CP88-757	.	.	.	.	358
CP88-758	.	.	.	.	348
CP88-764	.	.	.	.	EMGD
CP88-765	.	.	.	.	ABRT
CP88-767	.	.	.	.	NONE
CP88-769	.	.	.	.	INDC
CP88-770	.	.	.	.	NONE
CP88-772	.	.	.	.	EMGD
CP88-775	.	.	.	.	348
CP88-778	.	.	.	.	360
CP88-780	.	.	.	.	353
CP88-783	.	.	.	.	344
L78-063	278	.	.	INDC	.
L88-028	.	.	281	.	.
L88-030	.	.	302	.	.
L88-037	.	.	313	.	.
L88-046	.	.	288	.	.
L88-047	.	.	290	.	.
L88-049	.	.	NONE	.	.
L88-059	.	.	297	.	.
L88-060	269	.	.	.	.
L88-063	.	.	285	.	.
L88-066	EMGD	.	.	.	.
L88-069	266	.	.	.	.
L88-070	290	.	.	.	.
L88-072	274	.	.	.	.
L88-073	.	.	NONE	.	.
L88-075	.	.	278	.	.
L88-080	.	.	ABRT	.	.
L88-083	.	.	304	.	.
L88-086	.	.	306	.	.
L89-094	.	.	.	.	NONE
L89-095	.	.	.	.	369

Table 2. Continued.

Variety	Early Heat 1 Min	Early No Heat 1 Min	Late Heat 1 Min	Late Heat 0.5 Min	Heat Natural
L89-096	.	.	.	.	358
L89-097	.	.	.	.	NONE
L89-098	.	.	.	.	NONE
L89-099	.	.	.	.	NONE
L89-100	.	.	.	.	NONE
L89-101	.	.	.	.	NONE
L89-102	.	.	.	.	INDC
L89-103	.	.	.	.	EMGD
L89-104	.	.	.	.	INDC
L89-105	.	.	.	.	NONE
L89-107	.	.	.	.	INDC
L89-108	.	.	.	.	NONE
L89-110	.	.	.	.	NONE
L89-111	.	.	.	.	360
L89-112	.	.	.	.	351
L89-113	.	.	.	.	367
L89-114	.	.	.	.	362
L89-115	.	.	.	.	BOOT
L89-116	.	.	.	.	340
L89-117	.	.	.	.	INDC
L89-118	.	.	.	.	362
L89-119	.	.	.	.	NONE
L89-120	.	.	.	.	NONE
L89-121	.	.	.	.	360
L89-122	.	.	.	.	NONE
L89-123	.	.	.	.	BOOT
L89-124	.	.	.	.	INDC
L89-125	.	.	.	.	NONE
L89-126	.	.	.	.	358
L89-127	.	.	.	.	355
L89-129	.	.	.	.	NONE
L89-130	.	.	.	.	EMGD
L89-132	.	.	.	.	INDC
L89-133	.	.	.	.	NONE
L89-134	.	.	.	.	NONE
L89-135	.	.	.	.	NONE
L89-136	.	.	.	.	348
L89-137	.	.	.	.	NONE
L89-138	.	.	.	.	BOOT
L89-139	.	.	.	.	NONE
L89-140	.	.	.	.	NONE
L89-141	.	.	.	.	348
L89-142	.	.	.	.	NONE
L89-143	.	.	.	.	NONE
L89-144	.	.	.	.	351
L89-145	.	.	.	.	NONE
L89-146	.	.	.	.	355
L89-147	.	.	.	.	NONE
L89-148	.	.	.	.	NONE
L89-149	.	.	.	.	EMGD
L89-150	.	.	.	.	NONE
L89-151	.	.	.	.	INDC
L89-152	.	.	.	.	NONE
L89-155	.	.	.	.	362
L89-156	.	.	.	.	NONE
L89-157	.	.	.	.	INDC
L89-158	.	.	.	.	NONE
L89-159	.	.	.	.	NONE

Table 2. Continued.

Variety	Early Heat 1 Min	Early No Heat 1 Min	Late Heat 1 Min	Late Heat 0.5 Min	Heat Natural
L89-160	.	.	.	.	NONE
L89-161	.	.	.	.	NONE
L89-162	.	.	.	.	NONE
L89-163	.	.	.	.	BOOT
LCP81-010	283	288	.	313	.
LCP81-015	278	.	.	295	.
LCP81-030	278	281	.	302	NONE
LCP82-089	295	.	.	310	.
LCP83-153	310	.	.	NONE	.
LCP85-336	283	283	.	317	.
LCP85-376	267	266	.	290	.
LCP85-384	269	274	.	295	.
LCP86-393	.	.	295	.	.
LCP86-395	276	267	.	.	.
LCP86-402	281	278	295	302	.
LCP86-408	.	.	295	.	.
LCP86-420	276	267	.	283	.
LCP86-426	EMGD	310	.	.	.
LCP86-429	276	271	283	.	.
LCP86-454	.	.	281	.	.
LCP87-017	263	266	.	.	.
LCP87-018	267	263	.	.	.
LCP87-023	283	304	.	.	.
LCP87-472	.	.	266	.	.
LCP87-479	.	.	278	.	.
LCP87-491	.	.	NONE	.	.
LCP87-492	269	266	.	.	.
LCP87-494	.	.	290	.	.
LCP87-496	274	263	.	.	.
LCP88-078	.	.	INDC	.	.
LCP88-079	.	.	283	.	.
LCP88-090	.	.	NONE	.	.
LCP88-091	283	.	.	.	.
LCP88-093	.	.	NONE	.	.
US77-010	ABRT	.	281	.	.
US78-026	NONE	.	.	266	.
US80-004	.	.	285	.	.
US86-002	.	.	295	.	.

[1] Non-flowering responses based on most advanced stage.
[2] ABRT - aborted; BOOT - boot stage; EMGD - emerged; INDC - induced; NONE - no flowering response.

Table 3. Summary of the 1990 crossing campaign.

Type of cross	No. of crosses	No. of seed
Biparental	259	298,748
Polycross	30	43,078
Self	65	17,455
Total	354	359,281

Table 4. 1990 crossing data sorted by cross number.

Cross	Female	Male	Seed
XL90-001	LCP87-018	LCP87-496	0
XL90-002	LCP87-496	LCP87-496	6
XL90-003	LCP87-017	CP87-667	1551
XL90-004	LCP85-376	CP87-667	82
XL90-005	CP87-667	CP87-667	32
XL90-006	LCP87-017	LCP87-472	1176
XL90-007	LCP87-018	LCP87-472	10
XL90-008	LCP85-376	LCP87-472	94
XL90-009	LCP87-472	LCP87-472	0
XL90-010	LCP87-017	US78-026	840
XL90-011	LCP87-018	US78-026	8
XL90-012	LCP85-376	US78-026	37
XL90-013	US78-026	US78-026	115
XL90-014	LCP85-376	CP76-331	104
XL90-015	LCP87-018	CP76-331	140
XL90-016	LCP87-492	CP76-331	347
XL90-017	CP76-331	CP76-331	177
XL90-018	LCP85-376	LCP86-395	0
XL90-019	LCP87-492	LCP86-395	0
XL90-020	LCP86-395	LCP86-395	0
XL90-021	LCP85-376	LCP87-017	0
XL90-022	LCP87-017	LCP87-017	113
XL90-023	LCP85-376	LCP87-496	0
XL90-024	LCP87-018	LCP86-420	0
XL90-025	LCP86-420	LCP86-420	0
XL90-026	LCP87-492	LCP87-472	172
XL90-027	LCP87-492	LCP85-384	289
XL90-028	LCP85-384	LCP85-384	150
XL90-029	LCP87-492	CP85-830	8
XL90-030	CP85-830	CP85-830	14
XL90-031	L88-069	CP76-331	23
XL90-032	LCP86-429	CP85-830	405
XL90-033	L88-060	LCP87-472	318
XL90-034	CP87-615	US78-026	11
XL90-035	LCP86-429	CP76-331	994
XL90-036	L88-060	CP76-331	248
XL90-037	L88-069	CP87-662	502
XL90-038	CP87-662	CP87-662	0
XL90-039	CP65-357	CP76-331	5767
XL90-040	LCP87-496	CP76-331	970
XL90-041	LCP86-429	CP76-331	3962
XL90-042	CP78-317	CP76-331	1204
XL90-043	LCP87-017	CP76-331	1224
XL90-044	CP65-357	LCP85-384	3213
XL90-045	LCP86-395	LCP85-384	128
XL90-046	LCP86-496	CP77-407	422
XL90-047	CP77-407	CP77-407	120
XL90-048	CP74-383	CP87-626	69
XL90-049	CP87-626	CP87-626	136
XL90-050	CP65-357	CP85-830	1661
XL90-051	CP65-357	CP87-662	727
XL90-052	CP87-625	CP77-405	318
XL90-053	LCP86-420	CP77-405	115
XL90-054	CP77-405	CP77-405	1782
XL90-055	CP74-383	CP87-662	513
XL90-056	CP74-383	L88-069	11
XL90-057	L88-069	L88-069	7
XL90-058	CP74-383	CP85-830	99
XL90-059	CP74-383	LCP86-420	75
XL90-060	CP70-330	CP86-916	33
XL90-061	CP86-916	CP86-916	263
XL90-062	CP70-330	LCP86-395	120
XL90-063	CP70-330	CP76-331	1485
XL90-064	CP65-357	LCP86-429	100
XL90-065	LCP86-429	LCP86-429	35
XL90-066	CP65-357	LCP87-496	387
XL90-067	CP75-361	CP87-618	2128
XL90-068	CP87-618	CP87-618	86
XL90-069	LCP87-492	CP77-405	324
XL90-070	CP70-330	LCP85-384	188
XL90-071	CP74-383	LCP85-384	1274
XL90-072	CP87-625	CP78-317	64
XL90-073	CP78-317	CP78-317	35
XL90-074	CP86-912	CP79-318	88
XL90-075	CP74-383	CP79-318	680
XL90-076	CP79-318	CP79-318	0
XL90-077	CP86-974	LCP86-420	44
XL90-078	CP70-330	LCP86-420	0
XL90-079	LCP81-015	L88-075	988
XL90-080	L88-075	L88-075	0
XL90-081	CP76-351	CP87-618	1326
XL90-082	CP78-317	LCP87-479	1200
XL90-083	LCP87-479	LCP87-479	90
XL90-084	CP78-317	CP85-830	1090
XL90-085	CP70-330	LCP86-429	0
XL90-086	CP74-383	LCP86-395	144
XL90-087	CP86-916	CP76-331	3150
XL90-088	CP74-383	LCP87-496	292
XL90-089	CP78-317	LCP86-402	448
XL90-090	CP75-361	LCP86-402	1064
XL90-091	LCP86-402	LCP86-402	0
XL90-092	CP77-407	90P1	2955
XL90-093	L78-063	90P1	4284
XL90-094	CP77-405	90P1	2214
XL90-095	L88-072	90P1	1826
XL90-096	LCP81-030	90P1	566
XL90-097	CP87-625	CP79-318	32
XL90-098	CP72-370	CP86-916	1302
XL90-099	CP65-357	LCP86-402	1350
XL90-100	CP79-318	LCP86-395	0
XL90-101	CP74-383	LCP86-429	0
XL90-102	CP86-915	CP77-310	936
XL90-103	CP77-310	CP77-310	288
XL90-104	CP76-351	CP86-974	17
XL90-105	CP70-330	CP86-974	0
XL90-106	CP86-974	CP86-974	0
XL90-107	CP65-357	LCP86-454	424
XL90-108	LCP81-015	LCP86-454	1064
XL90-109	LCP81-030	LCP86-454	594
XL90-110	LCP86-454	LCP86-454	83
XL90-111	CP75-361	US77-010	4370
XL90-112	US77-010	US77-010	353
XL90-113	CP65-357	L88-028	265
XL90-114	CP74-383	L88-028	468
XL90-115	L88-028	L88-028	17
XL90-116	CP65-357	CP82-550	343
XL90-117	CP82-550	CP82-550	125
XL90-118	LCP86-395	L78-063	1188
XL90-119	L78-063	L78-063	810
XL90-120	CP65-357	CP87-626	1326
XL90-121	CP65-357	CP86-912	90
XL90-122	CP86-912	CP86-912	34
XL90-123	CP76-351	CP77-407	405
XL90-124	US78-026	90P1	414
XL90-125	LCP86-429	CP77-405	3285
XL90-126	CP65-357	LCP85-336	2808
XL90-127	LCP86-429	LCP85-336	4903
XL90-128	LCP85-336	LCP85-336	1711
XL90-129	CP74-383	CP70-321	184
XL90-130	CP65-357	CP70-321	132
XL90-131	CP70-321	CP70-321	102
XL90-132	LCP86-429	CP72-370	1505
XL90-133	CP72-370	CP72-370	315
XL90-134	LCP86-429	CP77-310	3204
XL90-135	LCP86-429	LCP85-384	3380
XL90-136	LCP81-015	LCP88-079	210

Table 4. Continued.

Cross	Female	Male	Seed
XL90-137	LCP88-079	LCP88-079	22
XL90-138	CP76-351	LCP88-091	3200
XL90-139	LCP88-091	LCP88-091	3689
XL90-140	CP87-649	LCP81-030	3326
XL90-141	LCP86-429	LCP81-030	3552
XL90-142	LCP87-023	LCP81-030	1794
XL90-143	LCP81-030	LCP81-030	510
XL90-144	CP76-351	LCP81-010	2100
XL90-145	LCP86-429	LCP81-010	1848
XL90-146	LCP81-010	LCP81-010	0
XL90-147	CP76-351	LCP86-420	68
XL90-148	CP75-361	LCP86-420	93
XL90-149	CP76-351	US77-010	2484
XL90-150	CP78-317	CP77-310	705
XL90-151	LCP81-015	L88-063	2528
XL90-152	L88-063	L88-063	713
XL90-153	LCP86-420	L78-063	647
XL90-154	CP74-383	US80-004	734
XL90-155	US80-004	US80-004	86
XL90-156	LCP81-015	L88-028	307
XL90-157	L88-028	L88-028	48
XL90-158	LCP81-030	LCP86-402	3796
XL90-159	CP70-321	LCP85-384	144
XL90-160	LCP81-015	LCP85-384	1782
XL90-161	LCP86-429	L88-063	3167
XL90-162	LCP86-429	LCP86-402	1824
XL90-163	LCP86-429	LCP87-496	805
XL90-164	LCP86-429	LCP86-395	644
XL90-165	LCP85-336	LCP81-030	1358
XL90-166	CP65-357	LCP86-420	37
XL90-167	LCP85-336	CP76-331	1956
XL90-168	CP86-974	CP72-370	322
XL90-169	LCP81-010	CP85-845	2557
XL90-170	CP85-845	CP85-845	546
XL90-171	CP77-310	L88-046	525
XL90-172	L88-046	L88-046	0
XL90-173	L88-070	90P2	242
XL90-174	LCP87-023	90P2	1296
XL90-175	CP87-649	90P2	1140
XL90-176	CP77-405	90P2	8112
XL90-177	L88-047	90P2	634
XL90-178	CP87-638	90P2	358
XL90-179	LCP86-420	LCP81-030	515
XL90-180	CP65-357	LCP81-010	4503
XL90-181	CP65-357	L88-046	146
XL90-182	LCP86-429	CP75-1082	1128
XL90-183	CP75-1082	CP75-1082	1638
XL90-184	CP76-331	CP77-310	1529
XL90-185	LCP86-429	CP77-310	2775
XL90-186	LCP86-420	L78-063	836
XL90-187	LCP86-429	L78-063	5506
XL90-188	CP75-361	LCP85-384	3672
XL90-189	LCP81-010	LCP85-336	2266
XL90-190	LCP86-429	CP78-317	4090
XL90-191	LCP85-376	CP78-317	764
XL90-192	LCP81-030	CP72-370	777
XL90-193	CP74-383	CP72-370	2521
XL90-194	LCP86-395	LCP87-494	88
XL90-195	LCP87-494	LCP87-494	0
XL90-196	CP65-357	L88-063	3480
XL90-197	CP75-361	CP86-933	1152
XL90-198	CP65-357	CP86-933	2374
XL90-199	CP86-933	CP86-933	500
XL90-200	CP70-330	LCP86-454	2160
XL90-201	CP77-310	CP75-1082	4520
XL90-202	CP75-361	CP75-1082	6600
XL90-203	LCP85-336	CP77-407	1232
XL90-204	CP72-370	LCP81-010	910
XL90-205	CP65-357	LCP81-010	2432
XL90-206	CP70-330	LCP87-023	594
XL90-207	CP75-361	LCP87-023	1290
XL90-208	LCP87-023	LCP87-023	17
XL90-209	CP70-330	LCP86-402	759
XL90-210	CP74-383	CP77-310	2654
XL90-211	CP65-357	LCP81-030	1560
XL90-212	L88-047	90P2	226
XL90-213	US86-002	90P2	255
XL90-214	CP87-665	90P2	490
XL90-215	CP75-361	LCP81-015	60
XL90-216	LCP81-015	LCP81-015	0
XL90-217	CP75-361	CP70-321	1479
XL90-218	LCP86-408	CP70-321	892
XL90-219	LCP86-408	CP77-310	1778
XL90-220	LCP86-408	CP82-550	23
XL90-221	CP65-357	CP82-550	0
XL90-222	CP74-383	CP75-1082	1487
XL90-223	CP86-974	LCP85-384	650
XL90-224	CP76-351	LCP85-384	2772
XL90-225	CP72-370	LCP85-384	900
XL90-226	CP75-361	LCP82-089	4680
XL90-227	LCP82-089	LCP82-089	715
XL90-228	CP75-361	CP85-803	1944
XL90-229	CP85-803	CP85-803	166
XL90-230	CP74-383	CP80-323	1905
XL90-231	CP80-323	CP80-323	202
XL90-232	CP75-361	CP73-343	1628
XL90-233	CP73-343	CP73-343	120
XL90-234	CP65-357	CP87-657	336
XL90-235	CP87-657	CP87-657	0
XL90-236	CP87-609	CP78-317	77
XL90-237	L88-070	CP78-317	184
XL90-238	US77-010	CP78-317	392
XL90-239	LCP86-393	CP77-310	1650
XL90-240	CP77-405	CP73-343	3172
XL90-241	LCP85-384	LCP81-010	3060
XL90-242	L88-059	LCP81-010	448
XL90-243	LCP85-384	LCP85-336	3780
XL90-244	LCP81-030	LCP85-376	741
XL90-245	LCP85-376	LCP85-376	0
XL90-246	LCP85-384	CP75-1082	4100
XL90-247	L88-059	CP75-1082	918
XL90-248	CP76-331	LCP85-384	1575
XL90-249	L88-079	CP74-383	0
XL90-250	CP87-644	CP74-383	221
XL90-251	CP74-383	CP74-383	70
XL90-252	CP76-331	CP85-845	336
XL90-253	CP78-317	US77-010	576
XL90-254	CP74-383	CP75-308	1195
XL90-255	CP75-308	CP75-308	742
XL90-256	CP86-974	CP80-323	0
XL90-257	LCP81-030	LCP82-089	3840
XL90-258	CP77-407	LCP82-089	2207
XL90-259	CP76-351	L88-070	371
XL90-260	L88-070	L88-070	16
XL90-261	CP74-383	LCP85-376	312
XL90-262	LCP85-376	LCP85-376	224
XL90-263	CP76-351	CP77-310	4896
XL90-264	LCP86-408	CP77-310	2100
XL90-265	CP76-351	LCP86-402	4229
XL90-266	CP75-361	CP82-550	500
XL90-267	LCP81-010	CP77-310	1660
XL90-268	CP83-644	CP77-310	3149
XL90-269	CP87-609	CP77-407	449
XL90-270	CP87-644	CP77-407	44
XL90-271	CP74-383	CP73-343	4980
XL90-272	CP77-405	LCP85-336	3264

Table 4. Continued.

Cross	Female	Male	Seed
XL90-273	CP74-383	LCP85-336	1176
XL90-274	CP70-321	LCP86-402	105
XL90-275	CP70-330	LCP86-402	255
XL90-276	CP77-405	LCP85-384	3536
XL90-277	LCP86-408	LCP85-384	2256
XL90-278	CP76-351	CP86-974	0
XL90-279	CP70-321	CP86-974	0
XL90-280	CP72-370	LCP86-393	370
XL90-281	LCP86-393	LCP86-393	77
XL90-282	CP80-329	CP77-310	664
XL90-283	CP86-974	CP77-310	122
XL90-284	LCP81-030	LCP86-393	361
XL90-285	CP70-330	LCP86-393	30
XL90-286	CP86-974	LCP81-030	105
XL90-287	L88-030	LCP81-030	749
XL90-288	CP86-917	LCP81-030	1579
XL90-289	CP87-657	L78-063	197
XL90-290	CP77-405	CP85-803	1882
XL90-291	LCP81-015	L88-046	146
XL90-292	CP70-321	LCP82-089	605
XL90-293	CP74-383	LCP82-089	4651
XL90-294	CP86-974	CP79-318	526
XL90-295	LCP87-494	CP76-351	15
XL90-296	CP70-330	CP76-351	100
XL90-297	CP76-351	CP76-351	77
XL90-298	CP76-331	LCP86-454	672
XL90-299	CP74-383	CP85-845	569
XL90-300	CP65-357	LCP87-023	10
XL90-301	US86-002	LCP85-384	763
XL90-302	LCP81-015	LCP86-402	2596
XL90-303	CP70-321	CP80-329	21
XL90-304	LCP86-420	CP80-329	72
XL90-305	CP80-329	CP80-329	13
XL90-306	CP87-609	CP77-310	218
XL90-307	CP85-803	CP77-407	1220
XL90-308	LCP86-408	CP80-323	876
XL90-309	CP78-357	CP80-323	552
XL90-310	CP75-361	CP80-323	3254
XL90-311	CP70-321	LCP86-393	0
XL90-312	CP86-917	LCP81-030	952
XL90-313	CP74-383	CP86-974	317
XL90-314	CP74-383	CP82-550	178
XL90-315	CP72-370	LCP87-494	415
XL90-316	LCP86-395	CP80-323	14
XL90-317	CP74-383	CP83-644	1051
XL90-318	CP70-330	CP83-644	436
XL90-319	CP83-644	CP83-644	60
XL90-320	CP70-321	CP78-357	442
XL90-321	CP78-357	CP78-357	52
XL90-322	CP70-321	CP86-917	82
XL90-323	CP86-917	CP86-917	154
XL90-324	LCP86-426	LCP82-089	170
XL90-325	LCP83-153	CP79-318	198
XL90-326	LCP83-153	LCP81-030	347
XL90-327	CP85-803	LCP86-393	112
XL90-328	CP75-361	90P3	2288
XL90-329	LCP85-336	90P3	3533
XL90-330	CP76-331	90P3	718
XL90-331	LCP86-402	CP75-361	32
XL90-332	CP75-361	CP75-361	0
XL90-333	LCP86-420	CP78-357	182
XL90-334	CP72-370	CP79-318	380
XL90-335	CP73-343	LCP81-010	141
XL90-336	CP76-351	LCP86-393	35
XL90-337	CP74-383	L88-046	10
XL90-338	L88-030	LCP86-402	68
XL90-339	CP75-1082	90P3	3637
XL90-340	LCP81-030	90P3	2440
XL90-341	LCP85-336	90P3	395
XL90-342	CP80-323	90P3	50
XL90-343	US78-026	90P3	1165
XL90-344	CP73-343	90P3	71
XL90-345	LCP86-426	CP77-407	0
XL90-346	CP70-321	CP74-383	31
XL90-347	CP82-550	LCP82-089	3162
XL90-348	LCP81-010	CP73-343	1404
XL90-349	LCP85-384	90P4	1514
XL90-350	LCP86-395	90P4	187
XL90-351	CP77-405	90P4	360
XL90-352	LCP85-336	90P4	631
XL90-353	LCP87-494	90P4	844
XL90-354	LCP81-015	90P4	235

Table 5. 1990 Crossing data sorted by female parent.

Cross	Female	Male	Seed
XL90-130	CP65-357	CP70-321	132
XL90-039	CP65-357	CP76-331	5767
XL90-116	CP65-357	CP82-550	343
XL90-221	CP65-357	CP82-550	0
XL90-050	CP65-357	CP85-830	1661
XL90-121	CP65-357	CP86-912	90
XL90-198	CP65-357	CP86-933	2374
XL90-120	CP65-357	CP87-626	1326
XL90-234	CP65-357	CP87-657	336
XL90-051	CP65-357	CP87-662	727
XL90-113	CP65-357	L88-028	265
XL90-181	CP65-357	L88-046	146
XL90-196	CP65-357	L88-063	3480
XL90-180	CP65-357	LCP81-010	4503
XL90-205	CP65-357	LCP81-010	2432
XL90-211	CP65-357	LCP81-030	1560
XL90-126	CP65-357	LCP85-336	2808
XL90-044	CP65-357	LCP85-384	3213
XL90-099	CP65-357	LCP86-402	1350
XL90-166	CP65-357	LCP86-420	37
XL90-064	CP65-357	LCP86-429	100
XL90-107	CP65-357	LCP86-454	424
XL90-300	CP65-357	LCP87-023	10
XL90-066	CP65-357	LCP87-496	387
XL90-131	CP70-321	CP70-321	102
XL90-346	CP70-321	CP74-383	31
XL90-320	CP70-321	CP78-357	442
XL90-303	CP70-321	CP80-329	21
XL90-322	CP70-321	CP86-917	82
XL90-279	CP70-321	CP86-974	0
XL90-292	CP70-321	LCP82-089	605
XL90-159	CP70-321	LCP85-384	144
XL90-311	CP70-321	LCP86-393	0
XL90-274	CP70-321	LCP86-402	105
XL90-063	CP70-330	CP76-331	1485
XL90-296	CP70-330	CP76-351	100
XL90-318	CP70-330	CP83-644	436
XL90-060	CP70-330	CP86-916	33
XL90-105	CP70-330	CP86-974	0
XL90-070	CP70-330	LCP85-384	188
XL90-285	CP70-330	LCP86-393	30
XL90-062	CP70-330	LCP86-395	120
XL90-209	CP70-330	LCP86-402	759
XL90-275	CP70-330	LCP86-402	255
XL90-078	CP70-330	LCP86-420	0
XL90-085	CP70-330	LCP86-429	0
XL90-200	CP70-330	LCP86-454	2160
XL90-206	CP70-330	LCP87-023	594
XL90-133	CP72-370	CP72-370	315
XL90-334	CP72-370	CP79-318	380
XL90-098	CP72-370	CP86-916	1302
XL90-204	CP72-370	LCP81-010	910
XL90-225	CP72-370	LCP85-384	900
XL90-280	CP72-370	LCP86-393	370
XL90-315	CP72-370	LCP87-494	415
XL90-344	CP73-343	90P3	71
XL90-233	CP73-343	CP73-343	120
XL90-335	CP73-343	LCP81-010	141
XL90-129	CP74-383	CP70-321	184
XL90-193	CP74-383	CP72-370	2521
XL90-271	CP74-383	CP73-343	4980
XL90-251	CP74-383	CP74-383	70
XL90-222	CP74-383	CP75-1082	1487
XL90-254	CP74-383	CP75-308	1195
XL90-210	CP74-383	CP77-310	2654
XL90-075	CP74-383	CP79-318	680
XL90-230	CP74-383	CP80-323	1905
XL90-314	CP74-383	CP82-550	178
XL90-317	CP74-383	CP83-644	1051
XL90-058	CP74-383	CP85-830	99
XL90-299	CP74-383	CP85-845	569
XL90-313	CP74-383	CP86-974	317
XL90-048	CP74-383	CP87-626	69
XL90-055	CP74-383	CP87-662	513
XL90-114	CP74-383	L88-028	468
XL90-337	CP74-383	L88-046	10
XL90-056	CP74-383	L88-069	11
XL90-293	CP74-383	LCP82-089	4651
XL90-273	CP74-383	LCP85-336	1176
XL90-261	CP74-383	LCP85-376	312
XL90-071	CP74-383	LCP85-384	1274
XL90-086	CP74-383	LCP86-395	144
XL90-059	CP74-383	LCP86-420	75
XL90-101	CP74-383	LCP86-429	0
XL90-088	CP74-383	LCP87-496	292
XL90-154	CP74-383	US80-004	734
XL90-339	CP75-1082	90P3	3637
XL90-183	CP75-1082	CP75-1082	1638
XL90-255	CP75-308	CP75-308	742
XL90-328	CP75-361	90P3	2288
XL90-217	CP75-361	CP70-321	1479
XL90-232	CP75-361	CP73-343	1628
XL90-202	CP75-361	CP75-1082	6600
XL90-332	CP75-361	CP75-361	0
XL90-310	CP75-361	CP80-323	3254
XL90-266	CP75-361	CP82-550	500
XL90-228	CP75-361	CP85-803	1944
XL90-197	CP75-361	CP86-933	1152
XL90-067	CP75-361	CP87-618	2128
XL90-215	CP75-361	LCP81-015	60
XL90-226	CP75-361	LCP82-089	4680
XL90-188	CP75-361	LCP85-384	3672
XL90-090	CP75-361	LCP86-402	1064
XL90-148	CP75-361	LCP86-420	93
XL90-207	CP75-361	LCP87-023	1290
XL90-111	CP75-361	US77-010	4370
XL90-330	CP76-331	90P3	718
XL90-017	CP76-331	CP76-331	177
XL90-184	CP76-331	CP77-310	1529
XL90-252	CP76-331	CP85-845	336
XL90-248	CP76-331	LCP85-384	1575
XL90-298	CP76-331	LCP86-454	672
XL90-297	CP76-351	CP76-351	77
XL90-263	CP76-351	CP77-310	4896
XL90-123	CP76-351	CP77-407	405
XL90-104	CP76-351	CP86-974	17
XL90-278	CP76-351	CP86-974	0
XL90-081	CP76-351	CP87-618	1326
XL90-259	CP76-351	L88-070	371
XL90-144	CP76-351	LCP81-010	2100
XL90-224	CP76-351	LCP85-384	2772
XL90-336	CP76-351	LCP86-393	35
XL90-265	CP76-351	LCP86-402	4229
XL90-147	CP76-351	LCP86-420	68
XL90-138	CP76-351	LCP88-091	3200
XL90-149	CP76-351	US77-010	2484
XL90-201	CP77-310	CP75-1082	4520
XL90-103	CP77-310	CP77-310	288
XL90-171	CP77-310	L88-046	525
XL90-094	CP77-405	90P1	2214
XL90-176	CP77-405	90P2	8112
XL90-351	CP77-405	90P4	360
XL90-240	CP77-405	CP73-343	3172
XL90-054	CP77-405	CP77-405	1782
XL90-290	CP77-405	CP85-803	1882
XL90-272	CP77-405	LCP85-336	3264

Table 5. Continued.

Cross	Female	Male	Seed
XL90-276	CP77-405	LCP85-384	3536
XL90-092	CP77-407	90P1	2955
XL90-047	CP77-407	CP77-407	120
XL90-258	CP77-407	LCP82-089	2207
XL90-042	CP78-317	CP76-331	1204
XL90-150	CP78-317	CP77-310	705
XL90-073	CP78-317	CP78-317	35
XL90-084	CP78-317	CP85-830	1090
XL90-089	CP78-317	LCP86-402	448
XL90-082	CP78-317	LCP87-479	1200
XL90-253	CP78-317	US77-010	576
XL90-321	CP78-357	CP78-357	52
XL90-309	CP78-357	CP80-323	552
XL90-076	CP79-318	CP79-318	0
XL90-100	CP79-318	LCP86-395	0
XL90-342	CP80-323	90P3	50
XL90-231	CP80-323	CP80-323	202
XL90-282	CP80-329	CP77-310	664
XL90-305	CP80-329	CP80-329	13
XL90-117	CP82-550	CP82-550	125
XL90-347	CP82-550	LCP82-089	3162
XL90-268	CP83-644	CP77-310	3149
XL90-319	CP83-644	CP83-644	60
XL90-307	CP85-803	CP77-407	1220
XL90-229	CP85-803	CP85-803	166
XL90-327	CP85-803	LCP86-393	112
XL90-030	CP85-830	CP85-830	14
XL90-170	CP85-845	CP85-845	546
XL90-074	CP86-912	CP79-318	88
XL90-122	CP86-912	CP86-912	34
XL90-102	CP86-915	CP77-310	936
XL90-087	CP86-916	CP76-331	3150
XL90-061	CP86-916	CP86-916	263
XL90-323	CP86-917	CP86-917	154
XL90-288	CP86-917	LCP81-030	1579
XL90-312	CP86-917	LCP81-030	952
XL90-199	CP86-933	CP86-933	500
XL90-168	CP86-974	CP72-370	322
XL90-283	CP86-974	CP77-310	122
XL90-294	CP86-974	CP79-318	526
XL90-256	CP86-974	CP80-323	0
XL90-106	CP86-974	CP86-974	0
XL90-286	CP86-974	LCP81-030	105
XL90-223	CP86-974	LCP85-384	650
XL90-077	CP86-974	LCP86-420	44
XL90-306	CP87-609	CP77-310	218
XL90-269	CP87-609	CP77-407	449
XL90-236	CP87-609	CP78-317	77
XL90-034	CP87-615	US78-026	11
XL90-068	CP87-618	CP87-618	86
XL90-052	CP87-625	CP77-405	318
XL90-072	CP87-625	CP78-317	64
XL90-097	CP87-625	CP79-318	32
XL90-049	CP87-626	CP87-626	136
XL90-178	CP87-638	90P2	358
XL90-250	CP87-644	CP74-383	221
XL90-270	CP87-644	CP77-407	44
XL90-175	CP87-649	90P2	1140
XL90-140	CP87-649	LCP81-030	3326
XL90-235	CP87-657	CP87-657	0
XL90-289	CP87-657	L78-063	197
XL90-038	CP87-662	CP87-662	0
XL90-214	CP87-665	90P2	490
XL90-005	CP87-667	CP87-667	32
XL90-093	L78-063	90P1	4284
XL90-119	L78-063	L78-063	810
XL90-115	L88-028	L88-028	17
XL90-157	L88-028	L88-028	48
XL90-287	L88-030	LCP81-030	749
XL90-338	L88-030	LCP86-402	68
XL90-172	L88-046	L88-046	0
XL90-177	L88-047	90P2	634
XL90-212	L88-047	90P2	226
XL90-247	L88-059	CP75-1082	918
XL90-242	L88-059	LCP81-010	448
XL90-036	L88-060	CP76-331	248
XL90-033	L88-060	LCP87-472	318
XL90-152	L88-063	L88-063	713
XL90-031	L88-069	CP76-331	23
XL90-037	L88-069	CP87-662	502
XL90-057	L88-069	L88-069	7
XL90-173	L88-070	90P2	242
XL90-237	L88-070	CP78-317	184
XL90-260	L88-070	L88-070	16
XL90-095	L88-072	90P1	1826
XL90-080	L88-075	L88-075	0
XL90-249	L88-079	CP74-383	0
XL90-348	LCP81-010	CP73-343	1404
XL90-267	LCP81-010	CP77-310	1660
XL90-169	LCP81-010	CP85-845	2557
XL90-146	LCP81-010	LCP81-010	0
XL90-189	LCP81-010	LCP85-336	2266
XL90-354	LCP81-015	90P4	235
XL90-156	LCP81-015	L88-028	307
XL90-291	LCP81-015	L88-046	146
XL90-151	LCP81-015	L88-063	2528
XL90-079	LCP81-015	L88-075	988
XL90-216	LCP81-015	LCP81-015	0
XL90-160	LCP81-015	LCP85-384	1782
XL90-302	LCP81-015	LCP86-402	2596
XL90-108	LCP81-015	LCP86-454	1064
XL90-136	LCP81-015	LCP88-079	210
XL90-096	LCP81-030	90P1	566
XL90-340	LCP81-030	90P3	2440
XL90-192	LCP81-030	CP72-370	777
XL90-143	LCP81-030	LCP81-030	510
XL90-257	LCP81-030	LCP82-089	3840
XL90-244	LCP81-030	LCP85-376	741
XL90-284	LCP81-030	LCP86-393	361
XL90-158	LCP81-030	LCP86-402	3796
XL90-109	LCP81-030	LCP86-454	594
XL90-227	LCP82-089	LCP82-089	715
XL90-325	LCP83-153	CP79-318	198
XL90-326	LCP83-153	LCP81-030	347
XL90-329	LCP85-336	90P3	3533
XL90-341	LCP85-336	90P3	395
XL90-352	LCP85-336	90P4	631
XL90-167	LCP85-336	CP76-331	1956
XL90-203	LCP85-336	CP77-407	1232
XL90-165	LCP85-336	LCP81-030	1358
XL90-128	LCP85-336	LCP85-336	1711
XL90-014	LCP85-376	CP76-331	104
XL90-191	LCP85-376	CP78-317	764
XL90-004	LCP85-376	CP87-667	82
XL90-245	LCP85-376	LCP85-376	0
XL90-262	LCP85-376	LCP85-376	224
XL90-018	LCP85-376	LCP86-395	0
XL90-021	LCP85-376	LCP87-017	0
XL90-008	LCP85-376	LCP87-472	94
XL90-023	LCP85-376	LCP87-496	0
XL90-012	LCP85-376	US78-026	37
XL90-349	LCP85-384	90P4	1514
XL90-246	LCP85-384	CP75-1082	4100
XL90-241	LCP85-384	LCP81-010	3060
XL90-243	LCP85-384	LCP85-336	3780
XL90-028	LCP85-384	LCP85-384	150

Table 5. Continued.

Cross	Female	Male	Seed
XL90-239	LCP86-393	CP77-310	1650
XL90-281	LCP86-393	LCP86-393	77
XL90-350	LCP86-395	90P4	187
XL90-316	LCP86-395	CP80-323	14
XL90-118	LCP86-395	L78-063	1188
XL90-045	LCP86-395	LCP85-384	128
XL90-020	LCP86-395	LCP86-395	0
XL90-194	LCP86-395	LCP87-494	88
XL90-331	LCP86-402	CP75-361	32
XL90-091	LCP86-402	LCP86-402	0
XL90-218	LCP86-408	CP70-321	892
XL90-219	LCP86-408	CP77-310	1778
XL90-264	LCP86-408	CP77-310	2100
XL90-308	LCP86-408	CP80-323	876
XL90-220	LCP86-408	CP82-550	23
XL90-277	LCP86-408	LCP85-384	2256
XL90-053	LCP86-420	CP77-405	115
XL90-333	LCP86-420	CP78-357	182
XL90-304	LCP86-420	CP80-329	72
XL90-153	LCP86-420	L78-063	647
XL90-186	LCP86-420	L78-063	836
XL90-179	LCP86-420	LCP81-030	515
XL90-025	LCP86-420	LCP86-420	0
XL90-345	LCP86-426	CP77-407	0
XL90-324	LCP86-426	LCP82-089	170
XL90-132	LCP86-429	CP72-370	1505
XL90-182	LCP86-429	CP75-1082	1128
XL90-035	LCP86-429	CP76-331	994
XL90-041	LCP86-429	CP76-331	3962
XL90-134	LCP86-429	CP77-310	3204
XL90-185	LCP86-429	CP77-310	2775
XL90-125	LCP86-429	CP77-405	3285
XL90-190	LCP86-429	CP78-317	4090
XL90-032	LCP86-429	CP85-830	405
XL90-187	LCP86-429	L78-063	5506
XL90-161	LCP86-429	L88-063	3167
XL90-145	LCP86-429	LCP81-010	1848
XL90-141	LCP86-429	LCP81-030	3552
XL90-127	LCP86-429	LCP85-336	4903
XL90-135	LCP86-429	LCP85-384	3380
XL90-164	LCP86-429	LCP86-395	644
XL90-162	LCP86-429	LCP86-402	1824
XL90-065	LCP86-429	LCP86-429	35
XL90-163	LCP86-429	LCP87-496	805
XL90-110	LCP86-454	LCP86-454	83
XL90-046	LCP86-496	CP77-407	422
XL90-043	LCP87-017	CP76-331	1224
XL90-003	LCP87-017	CP87-667	1551
XL90-022	LCP87-017	LCP87-017	113
XL90-006	LCP87-017	LCP87-472	1176
XL90-010	LCP87-017	US78-026	840
XL90-015	LCP87-018	CP76-331	140
XL90-024	LCP87-018	LCP86-420	0
XL90-007	LCP87-018	LCP87-472	10
XL90-001	LCP87-018	LCP87-496	0
XL90-011	LCP87-018	US78-026	8
XL90-174	LCP87-023	90P2	1296
XL90-142	LCP87-023	LCP81-030	1794
XL90-208	LCP87-023	LCP87-023	17
XL90-009	LCP87-472	LCP87-472	0
XL90-083	LCP87-479	LCP87-479	90
XL90-016	LCP87-492	CP76-331	347
XL90-069	LCP87-492	CP77-405	324
XL90-029	LCP87-492	CP85-830	8
XL90-027	LCP87-492	LCP85-384	289
XL90-019	LCP87-492	LCP86-395	0
XL90-026	LCP87-492	LCP87-472	172
XL90-353	LCP87-494	90P4	844
XL90-295	LCP87-494	CP76-351	15
XL90-195	LCP87-494	LCP87-494	0
XL90-040	LCP87-496	CP76-331	970
XL90-002	LCP87-496	LCP87-496	6
XL90-137	LCP88-079	LCP88-079	22
XL90-139	LCP88-091	LCP88-091	3689
XL90-238	US77-010	CP78-317	392
XL90-112	US77-010	US77-010	353
XL90-124	US78-026	90P1	414
XL90-343	US78-026	90P3	1165
XL90-013	US78-026	US78-026	115
XL90-155	US80-004	US80-004	86
XL90-213	US86-002	90P2	255
XL90-301	US86-002	LCP85-384	763

Table 6. 1990 crossing data sorted by male parent.

Cross	Female	Male	Seed
XL90-094	CP77-405	90P1	2214
XL90-092	CP77-407	90P1	2955
XL90-093	L78-063	90P1	4284
XL90-095	L88-072	90P1	1826
XL90-096	LCP81-030	90P1	566
XL90-124	US78-026	90P1	414
XL90-176	CP77-405	90P2	8112
XL90-178	CP87-638	90P2	358
XL90-175	CP87-649	90P2	1140
XL90-214	CP87-665	90P2	490
XL90-177	L88-047	90P2	634
XL90-212	L88-047	90P2	226
XL90-173	L88-070	90P2	242
XL90-174	LCP87-023	90P2	1296
XL90-213	US86-002	90P2	255
XL90-344	CP73-343	90P3	71
XL90-339	CP75-1082	90P3	3637
XL90-328	CP75-361	90P3	2288
XL90-330	CP76-331	90P3	718
XL90-342	CP80-323	90P3	50
XL90-340	LCP81-030	90P3	2440
XL90-329	LCP85-336	90P3	3533
XL90-341	LCP85-336	90P3	395
XL90-343	US78-026	90P3	1165
XL90-351	CP77-405	90P4	360
XL90-354	LCP81-015	90P4	235
XL90-352	LCP85-336	90P4	631
XL90-349	LCP85-384	90P4	1514
XL90-350	LCP86-395	90P4	187
XL90-353	LCP87-494	90P4	844
XL90-130	CP65-357	CP70-321	132
XL90-131	CP70-321	CP70-321	102
XL90-129	CP74-383	CP70-321	184
XL90-217	CP75-361	CP70-321	1479
XL90-218	LCP86-408	CP70-321	892
XL90-133	CP72-370	CP72-370	315
XL90-193	CP74-383	CP72-370	2521
XL90-168	CP86-974	CP72-370	322
XL90-192	LCP81-030	CP72-370	777
XL90-132	LCP86-429	CP72-370	1505
XL90-233	CP73-343	CP73-343	120
XL90-271	CP74-383	CP73-343	4980
XL90-232	CP75-361	CP73-343	1628
XL90-240	CP77-405	CP73-343	3172
XL90-348	LCP81-010	CP73-343	1404
XL90-346	CP70-321	CP74-383	31
XL90-251	CP74-383	CP74-383	70
XL90-250	CP87-644	CP74-383	221
XL90-249	L88-079	CP74-383	0
XL90-222	CP74-383	CP75-1082	1487
XL90-183	CP75-1082	CP75-1082	1638
XL90-202	CP75-361	CP75-1082	6600
XL90-201	CP77-310	CP75-1082	4520
XL90-247	L88-059	CP75-1082	918
XL90-246	LCP85-384	CP75-1082	4100
XL90-182	LCP86-429	CP75-1082	1128
XL90-254	CP74-383	CP75-308	1195
XL90-255	CP75-308	CP75-308	742
XL90-332	CP75-361	CP75-361	0
XL90-331	LCP86-402	CP75-361	32
XL90-039	CP65-357	CP76-331	5767
XL90-063	CP70-330	CP76-331	1485
XL90-017	CP76-331	CP76-331	177
XL90-042	CP78-317	CP76-331	1204
XL90-087	CP86-916	CP76-331	3150
XL90-036	L88-060	CP76-331	248
XL90-031	L88-069	CP76-331	23
XL90-167	LCP85-336	CP76-331	1956
XL90-014	LCP85-376	CP76-331	104
XL90-035	LCP86-429	CP76-331	994
XL90-041	LCP86-429	CP76-331	3962
XL90-043	LCP87-017	CP76-331	1224
XL90-015	LCP87-018	CP76-331	140
XL90-016	LCP87-492	CP76-331	347
XL90-040	LCP87-496	CP76-331	970
XL90-296	CP70-330	CP76-351	100
XL90-297	CP76-351	CP76-351	77
XL90-295	LCP87-494	CP76-351	15
XL90-210	CP74-383	CP77-310	2654
XL90-184	CP76-331	CP77-310	1529
XL90-263	CP76-351	CP77-310	4896
XL90-103	CP77-310	CP77-310	288
XL90-150	CP78-317	CP77-310	705
XL90-282	CP80-329	CP77-310	664
XL90-268	CP83-644	CP77-310	3149
XL90-102	CP86-915	CP77-310	936
XL90-283	CP86-974	CP77-310	122
XL90-306	CP87-609	CP77-310	218
XL90-267	LCP81-010	CP77-310	1660
XL90-239	LCP86-393	CP77-310	1650
XL90-219	LCP86-408	CP77-310	1778
XL90-264	LCP86-408	CP77-310	2100
XL90-134	LCP86-429	CP77-310	3204
XL90-185	LCP86-429	CP77-310	2775
XL90-054	CP77-405	CP77-405	1782
XL90-052	CP87-625	CP77-405	318
XL90-053	LCP86-420	CP77-405	115
XL90-125	LCP86-429	CP77-405	3285
XL90-069	LCP87-492	CP77-405	324
XL90-123	CP76-351	CP77-407	405
XL90-047	CP77-407	CP77-407	120
XL90-307	CP85-803	CP77-407	1220
XL90-269	CP87-609	CP77-407	449
XL90-270	CP87-644	CP77-407	44
XL90-203	LCP85-336	CP77-407	1232
XL90-345	LCP86-426	CP77-407	0
XL90-046	LCP86-496	CP77-407	422
XL90-073	CP78-317	CP78-317	35
XL90-236	CP87-609	CP78-317	77
XL90-072	CP87-625	CP78-317	64
XL90-237	L88-070	CP78-317	184
XL90-191	LCP85-376	CP78-317	764
XL90-190	LCP86-429	CP78-317	4090
XL90-238	US77-010	CP78-317	392
XL90-320	CP70-321	CP78-357	442
XL90-321	CP78-357	CP78-357	52
XL90-333	LCP86-420	CP78-357	182
XL90-334	CP72-370	CP79-318	380
XL90-075	CP74-383	CP79-318	680
XL90-076	CP79-318	CP79-318	0
XL90-074	CP86-912	CP79-318	88
XL90-294	CP86-974	CP79-318	526
XL90-097	CP87-625	CP79-318	32
XL90-325	LCP83-153	CP79-318	198
XL90-230	CP74-383	CP80-323	1905
XL90-310	CP75-361	CP80-323	3254
XL90-309	CP78-357	CP80-323	552
XL90-231	CP80-323	CP80-323	202
XL90-256	CP86-974	CP80-323	0
XL90-316	LCP86-395	CP80-323	14
XL90-308	LCP86-408	CP80-323	876
XL90-303	CP70-321	CP80-329	21
XL90-305	CP80-329	CP80-329	13
XL90-304	LCP86-420	CP80-329	72
XL90-116	CP65-357	CP82-550	343
XL90-221	CP65-357	CP82-550	0

Table 6. Continued.

Cross	Female	Male	Seed
XL90-314	CP74-383	CP82-550	178
XL90-266	CP75-361	CP82-550	500
XL90-117	CP82-550	CP82-550	125
XL90-220	LCP86-408	CP82-550	23
XL90-318	CP70-330	CP83-644	436
XL90-317	CP74-383	CP83-644	1051
XL90-319	CP83-644	CP83-644	60
XL90-228	CP75-361	CP85-803	1944
XL90-290	CP77-405	CP85-803	1882
XL90-229	CP85-803	CP85-803	166
XL90-050	CP65-357	CP85-830	1661
XL90-058	CP74-383	CP85-830	99
XL90-084	CP78-317	CP85-830	1090
XL90-030	CP85-830	CP85-830	14
XL90-032	LCP86-429	CP85-830	405
XL90-029	LCP87-492	CP85-830	8
XL90-299	CP74-383	CP85-845	569
XL90-252	CP76-331	CP85-845	336
XL90-170	CP85-845	CP85-845	546
XL90-169	LCP81-010	CP85-845	2557
XL90-121	CP65-357	CP86-912	90
XL90-122	CP86-912	CP86-912	34
XL90-060	CP70-330	CP86-916	33
XL90-098	CP72-370	CP86-916	1302
XL90-061	CP86-916	CP86-916	263
XL90-322	CP70-321	CP86-917	82
XL90-323	CP86-917	CP86-917	154
XL90-198	CP65-357	CP86-933	2374
XL90-197	CP75-361	CP86-933	1152
XL90-199	CP86-933	CP86-933	500
XL90-279	CP70-321	CP86-974	0
XL90-105	CP70-330	CP86-974	0
XL90-313	CP74-383	CP86-974	317
XL90-104	CP76-351	CP86-974	17
XL90-278	CP76-351	CP86-974	0
XL90-106	CP86-974	CP86-974	0
XL90-067	CP75-361	CP87-618	2128
XL90-081	CP76-351	CP87-618	1326
XL90-068	CP87-618	CP87-618	86
XL90-120	CP65-357	CP87-626	1326
XL90-048	CP74-383	CP87-626	69
XL90-049	CP87-626	CP87-626	136
XL90-234	CP65-357	CP87-657	336
XL90-235	CP87-657	CP87-657	0
XL90-051	CP65-357	CP87-662	727
XL90-055	CP74-383	CP87-662	513
XL90-038	CP87-662	CP87-662	0
XL90-037	L88-069	CP87-662	502
XL90-005	CP87-667	CP87-667	32
XL90-004	LCP85-376	CP87-667	82
XL90-003	LCP87-017	CP87-667	1551
XL90-289	CP87-657	L78-063	197
XL90-119	L78-063	L78-063	810
XL90-118	LCP86-395	L78-063	1188
XL90-153	LCP86-420	L78-063	647
XL90-186	LCP86-420	L78-063	836
XL90-187	LCP86-429	L78-063	5506
XL90-113	CP65-357	L88-028	265
XL90-114	CP74-383	L88-028	468
XL90-115	L88-028	L88-028	17
XL90-157	L88-028	L88-028	48
XL90-156	LCP81-015	L88-028	307
XL90-181	CP65-357	L88-046	146
XL90-337	CP74-383	L88-046	10
XL90-171	CP77-310	L88-046	525
XL90-172	L88-046	L88-046	0
XL90-291	LCP81-015	L88-046	146
XL90-196	CP65-357	L88-063	3480
XL90-152	L88-063	L88-063	713
XL90-151	LCP81-015	L88-063	2528
XL90-161	LCP86-429	L88-063	3167
XL90-056	CP74-383	L88-069	11
XL90-057	L88-069	L88-069	7
XL90-259	CP76-351	L88-070	371
XL90-260	L88-070	L88-070	16
XL90-080	L88-075	L88-075	0
XL90-079	LCP81-015	L88-075	988
XL90-180	CP65-357	LCP81-010	4503
XL90-205	CP65-357	LCP81-010	2432
XL90-204	CP72-370	LCP81-010	910
XL90-335	CP73-343	LCP81-010	141
XL90-144	CP76-351	LCP81-010	2100
XL90-242	L88-059	LCP81-010	448
XL90-146	LCP81-010	LCP81-010	0
XL90-241	LCP85-384	LCP81-010	3060
XL90-145	LCP86-429	LCP81-010	1848
XL90-215	CP75-361	LCP81-015	60
XL90-216	LCP81-015	LCP81-015	0
XL90-211	CP65-357	LCP81-030	1560
XL90-288	CP86-917	LCP81-030	1579
XL90-312	CP86-917	LCP81-030	952
XL90-286	CP86-974	LCP81-030	105
XL90-140	CP87-649	LCP81-030	3326
XL90-287	L88-030	LCP81-030	749
XL90-143	LCP81-030	LCP81-030	510
XL90-326	LCP83-153	LCP81-030	347
XL90-165	LCP85-336	LCP81-030	1358
XL90-179	LCP86-420	LCP81-030	515
XL90-141	LCP86-429	LCP81-030	3552
XL90-142	LCP87-023	LCP81-030	1794
XL90-292	CP70-321	LCP82-089	605
XL90-293	CP74-383	LCP82-089	4651
XL90-226	CP75-361	LCP82-089	4680
XL90-258	CP77-407	LCP82-089	2207
XL90-347	CP82-550	LCP82-089	3162
XL90-257	LCP81-030	LCP82-089	3840
XL90-227	LCP82-089	LCP82-089	715
XL90-324	LCP86-426	LCP82-089	170
XL90-126	CP65-357	LCP85-336	2808
XL90-273	CP74-383	LCP85-336	1176
XL90-272	CP77-405	LCP85-336	3264
XL90-189	LCP81-010	LCP85-336	2266
XL90-128	LCP85-336	LCP85-336	1711
XL90-243	LCP85-384	LCP85-336	3780
XL90-127	LCP86-429	LCP85-336	4903
XL90-261	CP74-383	LCP85-376	312
XL90-244	LCP81-030	LCP85-376	741
XL90-245	LCP85-376	LCP85-376	0
XL90-262	LCP85-376	LCP85-376	224
XL90-044	CP65-357	LCP85-384	3213
XL90-159	CP70-321	LCP85-384	144
XL90-070	CP70-330	LCP85-384	188
XL90-225	CP72-370	LCP85-384	900
XL90-071	CP74-383	LCP85-384	1274
XL90-188	CP75-361	LCP85-384	3672
XL90-248	CP76-331	LCP85-384	1575
XL90-224	CP76-351	LCP85-384	2772
XL90-276	CP77-405	LCP85-384	3536
XL90-223	CP86-974	LCP85-384	650
XL90-160	LCP81-015	LCP85-384	1782
XL90-028	LCP85-384	LCP85-384	150
XL90-045	LCP86-395	LCP85-384	128
XL90-277	LCP86-408	LCP85-384	2256
XL90-135	LCP86-429	LCP85-384	3380
XL90-027	LCP87-492	LCP85-384	289
XL90-301	US86-002	LCP85-384	763

Table 6. Continued.

Cross	Female	Male	Seed
XL90-311	CP70-321	LCP86-393	0
XL90-285	CP70-330	LCP86-393	30
XL90-280	CP72-370	LCP86-393	370
XL90-336	CP76-351	LCP86-393	35
XL90-327	CP85-803	LCP86-393	112
XL90-284	LCP81-030	LCP86-393	361
XL90-281	LCP86-393	LCP86-393	77
XL90-062	CP70-330	LCP86-395	120
XL90-086	CP74-383	LCP86-395	144
XL90-100	CP79-318	LCP86-395	0
XL90-018	LCP85-376	LCP86-395	0
XL90-020	LCP86-395	LCP86-395	0
XL90-164	LCP86-429	LCP86-395	644
XL90-019	LCP87-492	LCP86-395	0
XL90-099	CP65-357	LCP86-402	1350
XL90-274	CP70-321	LCP86-402	105
XL90-209	CP70-330	LCP86-402	759
XL90-275	CP70-330	LCP86-402	255
XL90-090	CP75-361	LCP86-402	1064
XL90-265	CP76-351	LCP86-402	4229
XL90-089	CP78-317	LCP86-402	448
XL90-338	L88-030	LCP86-402	68
XL90-302	LCP81-015	LCP86-402	2596
XL90-158	LCP81-030	LCP86-402	3796
XL90-091	LCP86-402	LCP86-402	0
XL90-162	LCP86-429	LCP86-402	1824
XL90-166	CP65-357	LCP86-420	37
XL90-078	CP70-330	LCP86-420	0
XL90-059	CP74-383	LCP86-420	75
XL90-148	CP75-361	LCP86-420	93
XL90-147	CP76-351	LCP86-420	68
XL90-077	CP86-974	LCP86-420	44
XL90-025	LCP86-420	LCP86-420	0
XL90-024	LCP87-018	LCP86-420	0
XL90-064	CP65-357	LCP86-429	100
XL90-085	CP70-330	LCP86-429	0
XL90-101	CP74-383	LCP86-429	0
XL90-065	LCP86-429	LCP86-429	35
XL90-107	CP65-357	LCP86-454	424
XL90-200	CP70-330	LCP86-454	2160
XL90-298	CP76-331	LCP86-454	672
XL90-108	LCP81-015	LCP86-454	1064
XL90-109	LCP81-030	LCP86-454	594
XL90-110	LCP86-454	LCP86-454	83
XL90-021	LCP85-376	LCP87-017	0
XL90-022	LCP87-017	LCP87-017	113
XL90-300	CP65-357	LCP87-023	10
XL90-206	CP70-330	LCP87-023	594
XL90-207	CP75-361	LCP87-023	1290
XL90-208	LCP87-023	LCP87-023	17
XL90-033	L88-060	LCP87-472	318
XL90-008	LCP85-376	LCP87-472	94
XL90-006	LCP87-017	LCP87-472	1176
XL90-007	LCP87-018	LCP87-472	10
XL90-009	LCP87-472	LCP87-472	0
XL90-026	LCP87-492	LCP87-472	172
XL90-082	CP78-317	LCP87-479	1200
XL90-083	LCP87-479	LCP87-479	90
XL90-315	CP72-370	LCP87-494	415
XL90-194	LCP86-395	LCP87-494	88
XL90-195	LCP87-494	LCP87-494	0
XL90-066	CP65-357	LCP87-496	387
XL90-088	CP74-383	LCP87-496	292
XL90-023	LCP85-376	LCP87-496	0
XL90-163	LCP86-429	LCP87-496	805
XL90-001	LCP87-018	LCP87-496	0
XL90-002	LCP87-496	LCP87-496	6
XL90-136	LCP81-015	LCP88-079	210
XL90-137	LCP88-079	LCP88-079	22
XL90-138	CP76-351	LCP88-091	3200
XL90-139	LCP88-091	LCP88-091	3689
XL90-111	CP75-361	US77-010	4370
XL90-149	CP76-351	US77-010	2484
XL90-253	CP78-317	US77-010	576
XL90-112	US77-010	US77-010	353
XL90-034	CP87-615	US78-026	11
XL90-012	LCP85-376	US78-026	37
XL90-010	LCP87-017	US78-026	840
XL90-011	LCP87-018	US78-026	8
XL90-013	US78-026	US78-026	115
XL90-154	CP74-383	US80-004	734
XL90-155	US80-004	US80-004	86

SELECTIONS, ADVANCEMENTS AND ASSIGNMENTS OF THE LOUISIANA, "L", SUGARCANE VARIETY DEVELOPMENT PROGRAM FOR THE YEAR 1990

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Each year the Louisiana, "L", Sugarcane Variety Development Program conducts a six-phase project aimed at developing improved sugarcane cultivars for the Louisiana sugarcane industry. These phases include crossing, seedling production and transplanting, single-stool seedling selection, evaluation in line trials and assignment, replicated infield variety testing and replicated outfield variety testing. In addition to variety development, the program also evaluates the entire clonal population to identify those clones that show potential as parental material. A summary of selections, advancements and assignments made during 1990 is presented in Table 1.

Sixty-five clones were assigned permanent "L90" numbers in October. These assignments were made in first stubble second line trial plots of the 1985 crossing series. A summary of all data collected on these varieties is presented in Table 2.

Eighty-four thousand seedlings from 192 crosses were potted in February, 1990 in the greenhouse complex in St. Gabriel, LA. Of these, 63,788 were established as single stools in the field. Selections were made in stubble single stools, and first and second line trials based on agronomic ratings, stalk number, stalk diameter, stalk height, pith, tube, smut resistance and lodging. Due to the severity of the preceding winter, far fewer clones were available for selection than in a normal year. For this reason, Brix readings were not taken in 1990; all clones selected were planted.

Reasons for eliminating clones from the program are shown in Table 3. In the first line trials, most clones were dropped due to poor agronomic ratings as compared to adjacent check plots. Lodging, smut and pith also contributed to the attrition of a large percentage of clones. In second line trial plots, low stalk number eliminated most clones while lodging, pith and smut also caused many clones to be dropped.

Cross evaluations are based on the percent of the progeny that advance through each stage of selection. Summaries of progeny performance through Assignment, Increase, Second Line, and First Line stages are presented in Tables 4, 5, 6, and 7 respectively. Crossing and planting decisions are based upon these evaluations. The percentile ranking statistic is calculated using the number of clones surviving planting and the number remaining in the most advanced stage of that series. This statistic is also used to estimate the general combining ability of each parent.

Table 1. Summary of selections, advancements and assignments made during 1990 by the Louisiana, "L", Sugarcane Variety Development Program.

Crossing series	No. of crosses	Seedlings trans-planted to field	Survived trans-planting	Over-wintered	Advanced to			Assigned
					First line	Second line	Increase	
85	219	77,000	73,620	64,094	3,582	616	255	65*
86	236	70,310	65,712	50,363	3,264	887	264*	
87	227	73,868	71,507	54,495	2,331	583*		
88	252	69,806	64,642	59,069	4,132*			
89	192	68,000*	63,788					

* Work performed in 1990

Table 2. Summary of the data on the varieties assigned permanent numbers in 1990.

Variety	Parents		Stalk Weight	Stalk Number	Cane Yield	Sugar Conc.	Sugar Yield
	Female	Male	lbs.	per A	tons/A	lbs/T	lbs/A
CP70-321			2.3	29531	35.2	229	8640
L90-164	CP75-308	CP69-1052	1.9	37468	35.3	203	7290
L90-165	LCP82-033	CP72-355	2.9	26531	37.4	222	8379
L90-166	CP79-301	CP69-373	2.5	34731	43.2	203	8747
L90-167	MISC		2.5	34137	42.4	215	9176
L90-168	CP79-332	CP70-321	2.2	34044	37.6	220	8331
L90-169	CP79-348	LCP81-030	2.2	40752	44.7	223	10080
L90-170	MISC		2.3	32071	36.2	234	8656
L90-171	CP74-383	LCP81-030	2.6	28947	37.3	227	8735
L90-172	CP78-357	LCP81-030	2.5	27634	35.1	206	7715
L90-173	LCP82-046	LCP81-030	2.3	44623	50.2	211	11355
L90-174	CP52-068	LCP81-030	1.9	34188	31.4	234	7548
L90-175	MISC		2.2	22705	23.8	200	4874
L90-176	MISC		2.2	35643	37.5	209	8126
L90-177	CP48-103	CP76-331	2.7	26368	35.4	216	7669
L90-178	CP79-311	LCP81-030	2.2	41307	46.1	248	12055
L90-179	LCP82-058	CP70-321	2.8	30411	42.8	239	10266
L90-180	CP79-332	CP73-351	2.3	35902	39.6	228	9017
L90-181	CP71-1240	CP72-355	2.9	33128	48.2	212	10900
L90-182	CP74-383	CP70-321	2.4	34191	40.0	236	9784
L90-183	L80-040	CP62-258	2.4	26779	33.0	236	8056
L90-184	CP74-383	LCP81-030	3.1	34694	53.4	198	11351
L90-185	CP65-357	CP70-321	2.2	32173	34.9	237	8402
L90-186	CP65-357	LCP81-030	2.2	37515	44.3	235	11109
L90-187	CP79-332	CP73-351	2.5	49872	62.4	212	14560
L90-188	CP52-068	LCP81-030	2.7	37826	50.5	218	11605
L90-189	CP61-037	CP73-351	2.3	36514	42.6	220	10020
L90-190	CP65-357	CP67-412	2.2	35753	38.1	231	9131
L90-191	CP79-318	LCP81-030	2.2	36319	39.7	234	8469
L90-192	CP79-348	L83-183	2.3	28698	33.2	236	8176
L90-193	CP80-328	CP72-355	2.0	31166	30.8	218	7161
L90-194	CP78-317	CP72-355	2.9	31165	47.7	228	12417
L90-195	CP52-068	LCP81-030	2.5	23250	28.2	256	7317
L90-196	LCP82-047	LCP81-030	2.1	32929	35.2	233	8435
L90-197	CP65-357	CP70-321	2.6	33328	43.7	223	10678
LCP90-198	US77-017	CP70-321	2.6	22245	32.3	218	8469
L90-199	CP78-317	CP72-355	1.6	36912	30.5	234	7454
L90-200	LCP81-012	LCP81-030	2.9	29748	45.4	240	11429
L90-201	LCP82-047	CP69-1052	2.1	28388	28.3	247	7015
L90-202	LCP81-009	LCP81-030	2.2	34036	37.8	239	9331
L90-203	MISC		2.4	33821	37.8	228	8568
L90-204	CP79-332	CP62-258	1.8	38682	36.6	227	8861
L90-205	CP79-332	CP70-321	2.3	39128	45.0	233	11342

continued

Table 2. continued

Variety	Parents		Stalk Weight	Stalk Number	Cane Yield	Sugar Conc.	Sugar Yield
	Female	Male	lbs.	per A	tons/A	lbs/T	lbs/A
L90-206	CP79-332	CP62-258	3.4	22993	38.8	242	9609
L90-207	CP72-1210	CP73-351	2.3	29395	34.8	232	8418
L90-208	MISC		2.2	26334	27.9	199	5873
L90-209	CP77-414	LCP81-030	2.5	33635	41.8	229	9288
L90-210	CP77-414	LCP81-030	1.9	30654	28.8	226	6611
L90-211	CP79-332	CP70-321	1.7	39179	32.0	225	7286
L90-212	CP78-317	CP72-355	2.0	28340	28.4	235	7122
L90-213	CP77-414	LCP81-030	2.1	33383	33.7	250	8354
L90-214	CP78-317	CP72-355	2.4	27737	34.4	225	7968
L90-215	CP72-370	POLY	2.0	33230	32.8	221	7239
L90-216	CP78-357	LCP81-030	2.3	44480	51.8	198	10881
L90-217	CP65-357	LCP81-030	2.0	34092	34.2	220	7878
L90-218	CP79-348	LCP81-030	2.6	27691	35.0	236	8245
L90-219	CP79-332	CP73-351	2.2	30107	32.2	228	7466
L90-220	CP79-332	CP73-351	1.9	29191	26.7	230	5853
L90-221	CP74-383	CP70-321	2.1	30913	32.8	245	8042
L90-222	MISC		2.6	37666	51.9	244	13997
L90-223	CP80-323	CP73-351	2.5	38120	47.9	224	11778
L90-224	CP72-2086	SELF	2.0	33078	33.6	205	6910
L90-225	LCP83-163	CP77-402	2.1	32633	35.2	223	8381
L90-226	CP80-351	CP76-301	2.7	34947	48.0	245	12338
L90-227	MISC		2.5	33479	41.0	219	9520
L90-228	LCP81-012	CP73-351	1.9	38723	36.2	219	8107

Table 3. Reasons for not advancing clones from the first and second line trials during 1990.

	From 1st line[1] to 2nd line		From 2nd line[2] to increase	
	number	(%)	number	(%)
Total	2710	100.00	887	100.00
Rating[3]	1574	58.08	7	0.79
Lodging	253	9.34	78	8.79
Smut	212	7.82	19	2.14
Pith	150	5.54	64	7.22
Stalk number	21	0.77	442	49.83
Short stalk	13	0.48	12	1.35
Borers	13	0.48	0	0.00
Rust	1	0.04	1	0.11
Tube	6	0.22	0	0.00
Advanced	583[4]	21.51	264	29.76

[1] 1987 crossing series.
[2] 1986 crossing series.
[3] Rating is primarily based upon stalk number but may be influenced by stalk weight, smut and other characteristics.
[4] 564 clones were dropped for faults other than rating; more than one fault was listed for 123 clones.

Table 4. Advancement summary of the 1982 through 1985 crossing series that were advanced to assignment based upon the percent advancement from survive to the assignment stage.

Female Parent	Male Parent	Survive[1]	Line 1[2]		Line 2[4]		Increase[5]		Assign[6]	
		No.	No.	%ile[3]	No.	%ile	No.	%ile	No.	%ile
BC2	SES205A	752	47	61	15	75	5	76	0	38
BC2	SES6	490	21	37	3	33	2	59	0	38
BC3	BENDA	1135	67	55	24	77	13	90	3	87
CP43-064	CP73-351	589	35	55	3	31	0	22	0	38
CP43-064	CP70-321	1093	48	38	6	32	0	22	0	38
CP43-064	CP76-331	198	8	33	1	31	1	70	0	38
CP43-064	CP78-349	263	5	12	1	24	0	22	0	38
CP43-064	CP57-614	398	18	39	0	10	0	22	0	38
CP43-064	CP78-355	185	11	55	1	32	1	72	0	38
CP43-064	CP70-330	244	6	18	0	10	0	22	0	38
CP43-064	CP69-373	322	12	28	3	45	0	22	0	38
CP48-103	CP76-331	189	12	61	5	83	3	95	1	96
CP48-103	LCP81-030	453	18	33	5	51	1	49	0	38
CP48-103	CP77-402	477	31	63	12	81	2	62	1	85
CP48-103	CP70-321	236	0	3	0	10	0	22	0	38
CP48-103	CP77-310	2338	121	46	25	50	7	54	4	83
CP48-103	CP69-1052	186	7	30	2	50	1	72	0	38
CP48-103	CP67-411	863	57	64	10	53	5	73	2	86
CP48-103	CP75-1082	386	24	59	5	58	1	51	1	87
CP48-103	CP62-258	1146	96	77	52	95	12	88	0	38
CP50-028	CP78-304	1036	108	89	32	88	10	86	1	77
CP50-028	CP77-310	226	10	38	1	27	0	22	0	38
CP52-068	CP80-360	236	14	55	4	69	0	22	0	38
CP52-068	CP75-308	828	55	64	13	66	3	56	1	79
CP52-068	L78-063	177	8	39	0	10	0	22	0	38
CP52-068	L65-069	209	5	17	0	10	0	22	0	38
CP52-068	CP72-370	1031	59	53	19	72	2	47	0	38
CP52-068	CP62-258	479	30	61	8	69	2	62	0	38
CP52-068	LCP81-030	1887	118	61	35	73	19	88	3	82
CP52-068	CP72-355	229	56	99	25	99	3	93	0	38
CP53-018	CP77-310	425	30	68	13	87	2	67	0	38
CP57-614	L83P2	216	8	28	0	10	0	22	0	38
CP57-614	CP62-258	216	15	66	1	29	0	22	0	38
CP57-614	CP57-614	131	5	30	4	87	0	22	0	38
CP60-016	CP72-356	431	14	24	3	36	0	22	0	38
CP60-016	CP78-321	853	6	7	3	23	1	45	0	38
CP60-016	CP77-310	488	10	13	0	10	0	22	0	38
CP60-016	CP72-370	76	8	89	0	10	0	22	0	38
CP61-037	CP70-321	944	34	27	4	25	1	45	0	38
CP61-037	CP57-614	594	21	26	2	23	1	46	0	38
CP61-037	L75-002	679	34	44	7	48	0	22	0	38
CP61-037	CP72-1312	257	13	45	1	24	0	22	0	38
CP61-037	CP76-301	217	7	24	1	29	1	66	0	38
CP61-037	CP77-310	148	7	41	2	59	0	22	0	38
CP61-037	CP73-351	799	34	37	5	34	3	57	1	79
CP61-037	CP78-304	787	73	83	14	71	5	75	1	80
CP61-037	CP80-319	44	0	3	0	10	0	22	0	38
CP61-037	CP76-331	221	0	3	0	10	0	22	0	38
CP61-039	CP80-319	496	0	3	0	10	0	22	0	38
CP61-039	CP67-412	486	0	3	0	10	0	22	0	38
CP61-039	CP72-2086	466	24	46	3	34	0	22	0	38
CP61-039	L78-063	444	18	34	6	59	2	65	0	38
CP61-039	CP57-614	434	18	34	5	53	1	50	0	38
CP61-039	CP72-355	205	5	17	0	10	0	22	0	38
CP61-039	FLORIDAS	222	10	39	2	43	1	65	0	38

Table 4. Continued.

Female Parent	Male Parent	Survive[1] No.	Line 1[2] No.	Line 1[2] %ile[3]	Line 2[4] No.	Line 2[4] %ile	Increase[5] No.	Increase[5] %ile	Assign[6] No.	Assign[6] %ile
CP61-039	CP66-346	475	15	24	4	40	1	48	0	38
CP62-258	CP72-255	196	6	23	1	31	0	22	0	38
CP62-258	CP62-258	150	9	57	1	35	0	22	0	38
CP65-357	CP70-330	1343	197	95	86	98	36	98	7	96
CP65-357	CP62-258	215	14	63	3	61	3	94	0	38
CP65-357	L65-069	242	5	14	1	25	0	22	0	38
CP65-357	CP77-402	1443	118	76	22	64	9	75	4	87
CP65-357	CP72-2086	1354	52	30	4	23	4	54	2	81
CP65-357	CP77-418	561	84	96	28	96	7	91	0	38
CP65-357	US80-009	139	5	27	3	78	0	22	0	38
CP65-357	CP67-412	113	10	80	1	42	1	84	1	98
CP65-357	CP69-373	683	48	67	14	76	5	79	1	81
CP65-357	CP70-321	610	33	49	9	63	4	76	3	94
CP65-357	SES231	241	0	3	0	10	0	22	0	38
CP65-357	L79-018	224	4	11	3	59	1	65	0	38
CP65-357	MANDALAY	249	0	3	0	10	0	22	0	38
CP65-357	CP69-1052	485	21	37	2	25	2	60	0	38
CP65-357	US77-010	233	1	6	0	10	0	22	0	38
CP65-357	LCP81-030	2775	203	69	46	69	18	76	11	90
CP65-357	US78-20	496	24	42	8	67	2	59	1	84
CP65-357	L78-063	453	22	42	1	21	0	22	0	38
CP65-357	CP77-413	364	31	78	12	89	4	89	0	38
CP66-346	CP57-614	216	3	9	0	10	0	22	0	38
CP66-346	CP66-346	232	4	11	1	26	0	22	0	38
CP66-346	CP70-330	662	62	84	28	94	11	96	5	98
CP67-412	CP70-330	97	47	99	19	99	6	99	0	38
CP67-412	CP70-321	690	16	15	1	20	0	22	0	38
CP67-412	CP77-310	364	0	3	0	10	0	22	0	38
CP67-412	L75-002	405	18	38	1	22	0	22	0	38
CP67-412	CP77-413	1185	73	59	18	64	4	56	0	38
CP67-412	L83P2	244	12	42	5	76	1	60	1	91
CP67-412	CP67-412	221	5	15	0	10	0	22	0	38
CP68-413	US81-042	102	3	21	0	10	0	22	0	38
CP69-373	L78-063	216	5	15	0	10	0	22	0	38
CP69-373	CP67-412	206	39	98	14	98	2	87	0	38
CP69-1052	CP69-1052	50	1	13	0	10	0	22	0	38
CP70-300	CP72-1312	193	8	34	2	49	1	71	1	95
CP70-300	CP72-355	678	40	55	7	48	2	54	1	81
CP70-300	CP75-1091	202	2	8	0	10	0	22	0	38
CP70-300	LCP81-030	705	67	85	13	72	4	73	3	92
CP70-300	US77-010	190	7	28	2	49	1	71	0	38
CP70-300	CP73-351	29	0	3	0	10	0	22	0	38
CP70-300	CP67-412	512	13	15	0	10	0	22	0	38
CP70-300	CP75-1082	399	21	48	9	78	1	51	1	86
CP70-310	CP72-355	240	15	61	5	76	1	61	0	38
CP70-310	CP76-301	296	7	17	2	35	0	22	0	38
CP70-310	CP57-614	220	14	62	1	28	1	66	0	38
CP70-321	CP62-258	680	48	68	16	80	4	74	1	81
CP70-321	CP75-308	757	49	63	12	66	4	71	2	87
CP70-321	CP80-323	235	19	75	6	82	4	96	0	38
CP70-321	CP77-402	72	3	36	0	10	0	22	0	38
CP70-321	CP73-351	485	20	34	8	68	1	48	0	38
CP70-321	CP66-346	456	13	21	2	27	0	22	0	38
CP70-321	CP67-412	272	17	61	5	72	1	57	0	38
CP70-321	82P1	110	4	27	1	44	0	22	0	38
CP70-321	CP72-355	212	4	12	1	29	0	22	0	38

Table 4. Continued.

Female Parent	Male Parent	Survive[1] No.	Line 1[2] No.	Line 1[2] %ile[3]	Line 2[4] No.	Line 2[4] %ile	Increase[5] No.	Increase[5] %ile	Assign[6] No.	Assign[6] %ile
CP70-330	US80-008	228	14	58	3	58	2	84	0	38
CP70-330	CP62-258	213	8	30	0	10	0	22	0	38
CP70-330	LCP81-030	566	28	42	4	36	2	56	0	38
CP70-330	L78-063	855	32	28	8	45	2	50	2	86
CP70-330	L75-002	2102	123	55	21	47	6	53	1	76
CP70-330	CP77-310	338	24	68	6	71	1	54	1	88
CP70-330	CP66-346	193	4	14	0	10	0	22	0	38
CP70-330	CP76-331	1304	84	62	25	74	4	55	1	77
CP70-330	CP78-321	238	9	30	3	56	2	82	1	92
CP70-330	CP80-323	217	8	28	2	44	1	66	0	38
CP70-330	CP69-1052	188	35	98	8	94	3	96	0	38
CP70-330	CP76-301	217	29	94	7	89	3	94	0	38
CP70-330	CP67-412	553	33	57	11	75	4	79	2	89
CP70-330	CP72-1210	87	3	25	1	53	0	22	0	38
CP70-330	CP72-1312	200	14	67	2	47	1	70	1	95
CP70-330	CP72-355	642	37	54	3	29	0	22	0	38
CP70-330	CP72-370	223	10	39	3	59	2	85	2	99
CP70-330	CP72-356	444	45	87	16	91	6	93	0	38
CP70-330	LCP82-089	230	6	18	1	26	0	22	0	38
CP70-330	CP75-1091	128	7	51	2	65	1	80	0	38
CP70-330	CP77-407	147	14	85	1	35	1	77	0	38
CP70-1133	CP78-349	322	10	23	5	65	1	55	0	38
CP70-1133	CP78-304	546	29	48	4	37	0	22	0	38
CP71-357	CP67-412	230	10	37	3	58	1	63	0	38
CP71-380	L65-069	156	8	45	2	57	0	22	0	38
CP71-380	CP77-310	197	16	75	2	48	1	70	0	38
CP71-380	CP66-346	529	28	48	4	38	0	22	0	38
CP71-380	CP77-402	261	19	69	2	38	1	58	0	38
CP71-380	CP72-355	87	8	83	1	53	0	22	0	38
CP71-441	CP76-301	233	26	91	2	42	2	83	0	38
CP71-441	CP70-321	506	13	18	1	20	1	47	0	38
CP71-459	CP69-373	228	0	3	0	10	0	22	0	38
CP71-459	CP72-2086	76	0	3	0	10	0	22	0	38
CP71-459	CP71-459	93	0	3	0	10	0	22	0	38
CP71-1086	L65-069	501	33	64	6	54	2	59	0	38
CP71-1194	CP72-355	1444	62	37	9	34	1	44	0	38
CP71-1194	L65-069	474	24	45	4	40	1	48	0	38
CP71-1194	CP62-258	1368	76	52	16	54	3	49	0	38
CP71-1240	CP71-1240	212	1	6	0	10	0	22	0	38
CP71-1240	CP72-355	883	50	53	20	79	6	77	1	78
CP72-353	CP73-343	125	11	80	6	95	0	22	0	38
CP72-355	CP77-407	149	22	96	6	93	0	22	0	38
CP72-355	CP67-412	637	19	22	9	61	0	22	0	38
CP72-355	LCP81-030	934	161	97	60	98	4	63	0	38
CP72-355	CP77-310	263	26	86	4	64	0	22	0	38
CP72-356	CP57-614	626	38	58	10	67	0	22	0	38
CP72-356	CP77-414	236	14	55	0	10	0	22	0	38
CP72-356	CP70-330	844	50	55	18	77	11	92	5	97
CP72-370	CP70-321	262	20	71	10	92	1	58	1	90
CP72-370	L80-045	169	39	99	6	91	0	22	0	38
CP72-370	L75-002	1217	108	80	36	87	15	91	7	96
CP72-370	CP80-329	903	79	79	28	88	8	85	1	78
CP72-370	US80-024	109	6	51	3	85	0	22	0	38
CP72-370	CP67-412	293	12	34	5	70	3	88	0	38
CP72-370	CP76-331	186	17	82	4	77	0	22	0	38
CP72-370	CP73-351	440	23	46	4	44	1	50	0	38

Table 4. Continued.

Female Parent	Male Parent	Survive[1] No.	Line 1[2] No.	Line 1[2] %ile[3]	Line 2[4] No.	Line 2[4] %ile	Increase[5] No.	Increase[5] %ile	Assign[6] No.	Assign[6] %ile
CP72-370	CP66-346	209	18	79	3	62	0	22	0	38
CP72-370	CP80-315	74	6	75	4	96	2	98	0	38
CP72-370	LCP81-030	1154	25	14	0	10	0	22	0	38
CP72-370	CP72-1210	82	12	95	7	99	0	22	0	38
CP72-370	CP62-258	2573	252	85	96	91	36	94	5	84
CP72-370	L83P2	866	45	46	11	56	1	45	1	78
CP72-370	L65-069	1186	78	64	19	67	3	51	0	38
CP72-370	CP77-310	404	25	59	6	63	2	70	0	38
CP72-1210	L65-069	606	35	54	2	23	0	22	0	38
CP72-1210	L83P2	177	10	52	2	52	0	22	0	38
CP72-1210	CP73-351	225	8	27	2	43	1	64	1	93
CP72-1210	CP70-321	221	21	85	1	28	1	66	0	38
CP72-1312	CP72-370	16	0	3	0	10	0	22	0	38
CP72-1312	CP57-614	306	26	78	5	68	2	76	0	38
CP72-1312	CP72-355	445	23	46	11	80	5	89	0	38
CP72-1312	L65-069	651	38	54	10	65	0	22	0	38
CP72-2086	L75-002	997	80	75	19	74	9	85	2	84
CP72-2086	CP72-2086	55	3	51	1	71	1	97	1	99
CP73-308	CP77-413	1498	97	63	40	83	11	79	1	76
CP73-345	CP72-370	168	13	72	6	91	4	98	1	97
CP73-345	CP76-301	341	27	74	5	63	0	22	0	38
CP73-345	CP78-304	234	36	97	8	90	2	83	0	38
CP73-345	CP77-402	661	33	44	6	44	2	54	0	38
CP73-345	CP73-351	140	7	44	0	10	0	22	0	38
CP73-345	CP62-258	448	44	85	21	95	8	97	0	38
CP73-345	CP77-407	220	27	93	3	60	3	93	0	38
CP73-345	LCP81-030	922	70	71	7	38	3	55	0	38
CP73-375	L75-002	787	39	44	5	34	1	46	1	80
CP73-375	CP66-346	137	2	10	1	37	1	79	1	98
CP73-1547	CP76-331	82	3	28	1	55	0	22	0	38
CP74-309	L65-069	526	36	65	8	64	4	80	0	38
CP74-322	CP77-403	416	58	95	25	97	8	97	1	86
CP74-328	CP57-614	454	25	51	2	27	0	22	0	38
CP74-383	LCP82-076	217	7	24	0	10	0	22	0	38
CP74-383	CP78-304	980	51	46	9	44	4	59	1	77
CP74-383	CP80-323	731	43	55	14	74	2	52	1	80
CP74-383	CP70-330	521	57	90	22	93	10	97	2	90
CP74-383	CP72-355	2383	190	75	26	51	3	46	1	76
CP74-383	CP79-327	344	25	69	5	62	0	22	0	38
CP74-383	CP77-414	389	14	27	5	57	0	22	0	38
CP74-383	CP69-373	923	43	41	5	32	0	22	0	38
CP74-383	L80-043	240	0	3	0	10	0	22	0	38
CP74-383	CP78-349	867	69	75	23	83	12	94	2	86
CP74-383	CP78-338	229	9	31	2	42	1	63	0	38
CP74-383	CP75-308	385	17	38	7	71	2	71	0	38
CP74-383	CP77-418	757	85	91	38	96	15	97	1	80
CP74-383	CP72-1312	244	19	73	6	80	0	22	0	38
CP74-383	CP73-351	160	2	8	0	10	0	22	0	38
CP74-383	CP67-412	862	45	46	12	60	6	77	2	86
CP74-383	CP72-356	921	93	87	29	89	10	89	0	38
CP74-383	CP74-2013	211	1	6	0	10	0	22	0	38
CP74-383	L79-018	64	4	61	2	88	0	22	0	38
CP74-383	LCP81-030	2138	165	72	26	55	12	73	4	83
CP74-383	CP76-301	1322	72	49	20	63	5	57	0	38
CP74-383	CP70-321	2231	148	64	48	77	16	78	7	88
CP74-383	CP57-614	646	40	59	5	38	2	55	0	38

Table 4. Continued.

Female Parent	Male Parent	Survive[1] No.	Line 1[2] No.	Line 1[2] %ile[3]	Line 2[4] No.	Line 2[4] %ile	Increase[5] No.	Increase[5] %ile	Assign[6] No.	Assign[6] %ile
CP74-387	CP72-2086	214	17	74	1	29	1	67	0	38
CP74-387	CP80-323	222	39	98	6	84	1	65	0	38
CP74-387	CP77-418	1276	129	87	37	86	10	81	2	82
CP74-387	CP70-330	810	55	65	15	73	4	69	1	79
CP74-1263	CP70-321	145	20	95	0	10	0	22	0	38
CP74-2005	CP76-331	210	2	8	0	10	0	22	0	38
CP74-2005	CP77-310	60	5	77	2	89	0	22	0	38
CP74-2005	CP73-351	12	0	3	0	10	0	22	0	38
CP75-308	CP70-321	1399	131	84	32	79	11	81	4	88
CP75-308	CP75-308	99	3	22	0	10	0	22	0	38
CP75-308	CP77-310	91	2	14	0	10	0	22	0	38
CP75-308	CP69-1052	252	20	74	4	66	3	91	1	90
CP75-308	CP72-2086	104	7	65	0	10	0	22	0	38
CP75-327	CP69-373	98	8	76	4	93	1	88	0	38
CP75-327	CP67-412	802	32	33	7	42	3	57	1	79
CP75-327	CP73-308	1586	129	75	47	87	14	84	3	83
CP75-327	CP57-614	74	1	9	0	10	0	22	0	38
CP75-327	CP77-418	826	91	90	24	86	5	74	1	79
CP75-327	CP77-402	929	56	57	15	67	7	79	0	38
CP75-360	CP73-351	113	0	3	0	10	0	22	0	38
CP75-360	CP76-331	570	22	31	5	42	1	47	1	83
CP75-361	IK76-066	23	2	79	1	95	1	99	0	38
CP75-361	CP78-355	204	10	42	4	75	0	22	0	38
CP75-361	CP77-418	525	48	82	8	64	3	73	1	84
CP75-361	US77-010	241	25	89	4	69	1	61	1	91
CP75-1082	CP75-1082	179	3	11	1	32	1	73	0	38
CP75-1091	CP78-304	256	4	10	0	10	0	22	0	38
CP75-1091	CP75-1091	115	0	3	0	10	0	22	0	38
CP75-1091	L83P2	871	26	22	2	22	1	45	0	38
CP75-1322	CP77-310	444	31	67	11	81	3	77	1	85
CP75-1632	CP76-331	67	2	22	0	10	0	22	0	38
CP76-301	L65-069	173	0	3	0	10	0	22	0	38
CP76-301	CP76-301	230	12	46	3	58	2	84	1	93
CP76-331	CP62-258	422	43	88	15	91	4	86	0	38
CP76-331	85P2	444	5	8	0	10	0	22	0	38
CP76-331	L83P1	233	7	22	0	10	0	22	0	38
CP76-331	CP76-331	160	0	3	0	10	0	22	0	38
CP76-331	US77-012	486	49	87	6	55	0	22	0	38
CP76-340	CP77-418	254	26	88	11	94	4	95	0	38
CP76-340	CP70-321	202	8	33	2	47	0	22	0	38
CP76-340	CP71-1240	217	15	66	0	10	0	22	0	38
CP76-340	CP72-370	117	3	18	1	41	0	22	0	38
CP76-340	CP77-407	542	50	83	11	76	7	92	0	38
CP76-350	CP73-351	2000	185	83	70	90	6	54	1	76
CP76-350	CP73-350	699	52	70	19	84	5	78	1	80
CP76-351	CP77-402	452	19	36	6	59	4	84	2	93
CP76-351	LCP81-030	616	56	82	6	46	3	69	1	82
CP76-351	CP70-321	140	6	37	4	86	1	78	1	98
CP77-310	US78-020	458	10	14	5	51	0	22	0	38
CP77-310	LCP82-076	225	7	23	2	43	1	64	0	38
CP77-310	CP77-403	1016	69	65	19	73	2	47	2	84
CP77-310	CP62-258	502	49	85	15	87	3	74	1	84
CP77-310	CP70-330	240	0	3	0	10	0	22	0	38
CP77-310	CP80-323	202	12	55	4	75	2	87	0	38
CP77-310	CP77-310	143	2	9	0	10	0	22	0	38
CP77-310	CP77-418	539	49	82	10	73	2	57	1	83

Table 4. Continued.

Female Parent	Male Parent	Survive[1] No.	Line 1[2] No.	Line 1[2] %ile[3]	Line 2[4] No.	Line 2[4] %ile	Increase[5] No.	Increase[5] %ile	Assign[6] No.	Assign[6] %ile
CP77-310	CP69-373	223	9	33	1	28	0	22	0	38
CP77-310	CP77-414	176	2	8	1	32	0	22	0	38
CP77-402	L65-069	574	29	45	18	88	4	78	0	38
CP77-402	L75-002	1154	45	31	14	54	3	51	0	38
CP77-402	CP77-402	100	0	3	0	10	0	22	0	38
CP77-403	CP66-346	855	99	92	34	93	8	86	1	78
CP77-405	CP72-355	209	8	30	1	30	1	68	0	38
CP77-405	84P2	190	8	36	4	77	1	71	0	38
CP77-405	CP76-331	281	26	83	6	77	0	22	0	38
CP77-405	LCP81-030	704	30	37	2	23	1	46	0	38
CP77-411	L78-063	475	11	15	1	21	0	22	0	38
CP77-413	85P1	242	26	90	4	68	3	91	0	38
CP77-414	LCP81-030	588	31	48	5	41	4	77	3	95
CP77-414	CP70-321	161	5	23	2	56	0	22	0	38
CP77-414	CP72-370	443	38	79	7	66	1	49	0	38
CP77-414	CP67-412	252	6	17	2	38	1	59	0	38
CP77-414	CP80-323	237	16	65	2	40	0	22	0	38
CP77-416	CP76-301	377	19	44	5	59	0	22	0	38
CP77-1414	CP77-414	189	2	8	1	31	0	22	0	38
CP78-304	CP78-304	164	16	85	3	72	1	75	1	97
CP78-304	CP77-310	1056	64	58	12	52	5	68	0	38
CP78-304	CP72-356	408	10	18	2	30	1	50	0	38
CP78-304	CP72-355	221	8	27	2	43	0	22	0	38
CP78-310	CP75-1091	37	3	75	1	84	0	22	0	38
CP78-310	CP57-614	245	19	73	3	55	1	59	0	38
CP78-310	CP62-258	97	6	59	1	48	0	22	0	38
CP78-317	CP77-310	615	68	91	13	77	7	90	2	89
CP78-317	CP72-2086	236	17	68	4	69	2	82	2	98
CP78-317	CP77-413	70	0	3	0	10	0	22	0	38
CP78-317	CP72-355	669	37	51	13	74	5	79	4	97
CP78-317	CP79-302	403	23	53	1	22	0	22	0	38
CP78-317	CP62-258	200	17	78	0	10	0	22	0	38
CP78-317	CP76-301	704	32	39	12	70	6	83	2	88
CP78-317	CP77-418	258	16	59	4	65	0	22	0	38
CP78-317	CP77-402	6	0	3	0	10	0	22	0	38
CP78-317	CP77-407	16	0	3	0	10	0	22	0	38
CP78-317	L78-063	165	15	82	7	94	1	75	1	97
CP78-317	CP66-346	106	0	3	0	10	0	22	0	38
CP78-317	LCP81-030	699	105	96	44	98	12	96	3	92
CP78-321	CP78-321	65	0	3	0	10	0	22	0	38
CP78-338	CP77-413	185	7	30	1	32	1	72	0	38
CP78-338	CP77-418	682	19	20	9	58	3	64	0	38
CP78-344	CP77-310	759	53	67	18	80	5	76	2	87
CP78-344	CP73-308	370	24	63	10	84	5	93	1	87
CP78-344	CP66-346	193	16	77	2	49	0	22	0	38
CP78-344	CP77-418	256	37	95	7	84	1	58	0	38
CP78-344	CP78-304	94	10	89	4	94	2	98	0	38
CP78-357	L75-002	750	47	61	21	85	2	52	0	38
CP78-357	CP73-351	373	16	37	3	39	1	52	0	38
CP78-357	CP76-331	249	15	57	0	10	0	22	0	38
CP78-357	LCP81-030	405	31	72	7	70	2	69	2	95
CP78-357	CP77-407	219	34	97	13	97	3	94	0	38
CP78-357	L65-069	462	16	26	4	42	1	49	0	38
CP78-357	CP70-321	217	8	28	6	85	0	22	0	38
CP78-357	CP75-308	1097	50	40	28	82	9	82	1	77
CP78-2114	LCP81-026	66	0	3	0	10	0	22	0	38

Table 4. Continued.

Female Parent	Male Parent	Survive[1] No.	Line 1[2] No.	Line 1[2] %ile[3]	Line 2[4] No.	Line 2[4] %ile	Increase[5] No.	Increase[5] %ile	Assign[6] No.	Assign[6] %ile
CP78-2114	CP73-351	109	0	3	0	10	0	22	0	38
CP78-3387	CP79-302	199	9	39	4	75	0	22	0	38
CP79-300	LCP83-152	80	6	71	0	10	0	22	0	38
CP79-301	CP80-346	230	19	77	9	92	2	84	0	38
CP79-301	CP66-346	187	20	90	5	83	0	22	0	38
CP79-301	CP68-1026	124	19	96	1	39	0	22	0	38
CP79-301	CP77-418	341	25	69	9	83	0	22	0	38
CP79-301	CP62-258	712	64	81	20	85	8	89	0	38
CP79-301	CP69-373	692	40	54	11	66	5	79	1	81
CP79-301	CP70-330	596	53	80	11	73	1	46	0	38
CP79-301	CP80-323	216	33	96	18	98	1	67	0	38
CP79-302	CP70-330	612	60	85	14	79	6	87	0	38
CP79-302	LCP81-026	203	31	96	11	97	3	95	0	38
CP79-302	84P2	422	42	86	13	87	6	94	2	94
CP79-302	CP72-356	270	21	73	13	96	3	89	1	89
CP79-302	CP77-418	81	14	98	6	98	0	22	0	38
CP79-302	CP80-323	427	40	84	17	93	8	97	5	99
CP79-302	CP67-412	237	45	98	9	92	1	62	1	92
CP79-311	CP76-301	457	28	58	7	65	5	89	2	93
CP79-311	CP77-310	142	11	72	1	36	0	22	0	38
CP79-311	LCP81-030	1732	68	31	17	46	5	53	1	76
CP79-318	CP69-1052	205	17	77	2	46	1	69	0	38
CP79-318	CP72-1312	232	4	11	0	10	0	22	0	38
CP79-318	CP70-321	1453	57	31	25	70	4	52	0	38
CP79-318	CP80-313	206	0	3	0	10	0	22	0	38
CP79-318	CP73-351	194	8	34	0	10	0	22	0	38
CP79-318	CP72-355	1705	114	65	19	51	2	45	0	38
CP79-318	CP76-301	184	6	25	2	51	1	72	0	38
CP79-318	CP66-346	364	22	57	5	60	1	52	0	38
CP79-318	CP78-304	150	24	97	7	95	3	98	0	38
CP79-318	LCP82-089	257	10	31	0	10	0	22	0	38
CP79-318	US79-007	491	20	34	1	20	0	22	0	38
CP79-318	US80-008	231	27	93	9	92	2	83	0	38
CP79-318	US80-024	442	19	37	3	35	2	66	1	85
CP79-318	LCP81-030	688	37	49	5	37	2	53	1	81
CP79-318	CP72-370	106	5	41	0	10	0	22	0	38
CP79-318	CP72-2086	475	13	19	3	34	0	22	0	38
CP79-318	US77-010	235	13	51	2	41	0	22	0	38
CP79-318	CP62-258	166	8	42	1	33	1	74	0	38
CP79-318	CP80-323	209	27	94	11	96	1	68	1	94
CP79-332	CP62-258	525	37	67	5	45	2	58	2	89
CP79-332	US80-011	148	19	94	8	96	3	98	0	38
CP79-332	CP75-308	482	61	94	15	88	2	61	0	38
CP79-332	CP66-346	233	6	18	1	26	0	22	0	38
CP79-332	CP72-370	551	73	94	8	62	5	85	2	89
CP79-332	CP69-1052	492	30	58	7	61	3	75	0	38
CP79-332	CP76-331	223	20	81	1	28	0	22	0	38
CP79-332	CP77-310	616	66	90	14	79	7	90	1	82
CP79-332	LCP81-030	187	10	48	1	31	1	71	0	38
CP79-332	CP67-412	484	27	52	4	40	2	60	1	85
CP79-332	CP72-355	537	35	63	6	52	2	57	0	38
CP79-332	CP73-351	708	29	34	8	52	6	82	4	96
CP79-332	US79-007	467	25	49	6	57	1	48	0	38
CP79-332	CP70-321	937	57	58	8	41	6	76	3	89
CP79-348	CP76-331	481	28	54	3	34	0	22	0	38
CP79-348	CP69-373	505	14	20	0	10	0	22	0	38

Table 4. Continued.

Female Parent	Male Parent	Survive[1] No.	Line 1[2] No.	Line 1[2] %ile[3]	Line 2[4] No.	Line 2[4] %ile	Increase[5] No.	Increase[5] %ile	Assign[6] No.	Assign[6] %ile
CP79-348	US80-024	173	7	33	6	90	1	73	0	38
CP79-348	LCP83-198	191	6	23	0	10	0	22	0	38
CP79-348	LCP81-030	690	45	63	13	73	8	90	2	88
CP79-348	CP77-414	242	6	18	1	25	0	22	0	38
CP79-348	LCP83-172	235	26	91	6	82	3	92	0	38
CP79-348	L83-183	239	10	36	3	56	2	82	1	92
CP79-348	CP72-355	301	14	41	2	35	1	55	0	38
CP79-348	CP74-387	229	17	70	2	42	1	63	0	38
CP79-348	CP72-370	166	15	81	10	97	5	99	1	97
CP80-313	CP76-301	155	9	54	1	35	0	22	0	38
CP80-313	LCP81-030	866	96	91	38	95	13	95	0	38
CP80-313	CP80-323	514	28	49	5	46	2	58	0	38
CP80-313	CP69-373	175	26	96	4	79	2	90	0	38
CP80-313	CP72-355	467	25	49	6	57	1	48	0	38
CP80-313	CP70-321	815	43	48	14	70	4	69	1	79
CP80-313	CP75-308	96	3	23	0	10	0	22	0	38
CP80-315	CP78-338	205	15	69	3	62	0	22	0	38
CP80-317	CP76-301	413	27	63	5	54	1	50	0	38
CP80-319	CP70-321	363	11	22	4	51	1	52	0	38
CP80-319	CP76-301	425	21	42	1	22	1	50	0	38
CP80-319	CP77-310	123	9	69	1	39	0	22	0	38
CP80-319	LCP81-030	242	9	28	1	25	1	60	0	38
CP80-319	CP69-1052	116	9	73	4	90	1	83	0	38
CP80-320	LCP81-018	218	0	3	0	10	0	22	0	38
CP80-323	CP73-351	245	22	81	3	55	2	81	1	91
CP80-324	CP77-310	70	1	9	0	10	0	22	0	38
CP80-324	CP70-321	93	6	63	0	10	0	22	0	38
CP80-324	CP57-614	799	42	48	3	24	0	22	0	38
CP80-325	CP77-310	202	4	13	2	47	0	22	0	38
CP80-328	CP72-355	210	23	90	3	62	2	86	1	94
CP80-328	LCP81-030	261	10	30	1	24	0	22	0	38
CP80-328	CP76-331	166	5	22	0	10	0	22	0	38
CP80-328	CP77-402	205	24	93	3	62	0	22	0	38
CP80-328	CP76-301	222	25	92	1	28	0	22	0	38
CP80-328	CP70-321	474	28	55	6	56	2	62	0	38
CP80-329	LCP81-030	208	21	87	1	30	0	22	0	38
CP80-346	CP79-327	155	14	81	4	82	2	92	0	38
CP80-351	CP66-346	253	32	93	9	91	2	81	0	38
CP80-351	LCP81-030	238	24	87	6	81	3	92	0	38
CP80-351	CP76-301	249	24	85	6	80	1	59	1	91
CP80-351	CP74-2013	233	12	46	1	26	1	63	0	38
CP80-352	CP76-301	248	23	83	5	76	4	96	0	38
CP80-352	CP75-308	392	20	45	5	57	2	70	0	38
CP80-352	CP72-355	218	19	79	4	72	2	85	1	93
CP80-352	LCP81-018	397	17	37	3	38	1	51	0	38
CP80-352	CP73-351	472	16	25	1	21	1	48	0	38
CP80-352	L78-063	185	6	24	1	32	0	22	0	38
CP80-352	CP70-321	438	16	28	5	52	3	77	0	38
CP80-352	CP77-310	186	7	30	1	32	0	22	0	38
CP80-356	LCP82-089	230	0	3	0	10	0	22	0	38
CP80-356	CP66-346	218	5	15	0	10	0	22	0	38
CP80-356	CP78-304	475	52	90	13	84	3	75	0	38
CP80-356	CP74-2013	238	27	92	2	40	0	22	0	38
CP80-356	CP62-258	485	27	52	0	10	0	22	0	38
CP80-356	CP67-412	432	8	12	1	22	0	22	0	38
CP80-356	LCP81-030	429	13	22	1	22	0	22	0	38

Table 4. Continued.

Female Parent	Male Parent	Survive[1] No.	Line 1[2] No.	Line 1[2] %ile[3]	Line 2[4] No.	Line 2[4] %ile	Increase[5] No.	Increase[5] %ile	Assign[6] No.	Assign[6] %ile
CP80-356	CP70-321	223	11	42	1	28	0	22	0	38
CP80-356	CP76-301	176	5	20	2	52	0	22	0	38
CP80-356	CP72-1312	245	11	39	1	25	0	22	0	38
CP80-356	L75-002	381	6	10	4	49	1	51	0	38
CP80-356	CP73-351	400	9	15	0	10	0	22	0	38
CP80-356	CP69-1052	243	18	70	0	10	0	22	0	38
CP80-360	LCP81-030	145	8	51	0	10	0	22	0	38
CP80-360	CP76-331	215	16	70	3	61	1	67	0	38
CP81-307	L75-002	932	39	36	2	21	0	22	0	38
CP81-307	CP57-614	234	5	14	0	10	0	22	0	38
CP81-307	CP74-2013	214	15	67	0	10	0	22	0	38
CP81-311	L83-194	204	15	70	2	46	2	87	0	38
CP81-316	LCP81-026	243	24	86	3	55	1	60	0	38
CP81-338	LCP81-030	479	26	49	11	79	2	62	0	38
CP81-338	CP76-301	827	93	91	28	90	3	56	0	38
CP82-559	LCP83-198	226	18	75	3	59	1	64	0	38
CP82-528	L78-063	234	6	18	1	26	0	22	0	38
COLD TOL	LCP81-030	259	13	44	1	24	0	22	0	38
L65-069	CP76-301	204	8	31	2	46	1	69	0	38
L65-069	CP70-330	1197	27	15	9	37	2	46	2	83
L65-069	CP77-414	834	36	37	9	50	0	22	0	38
L65-069	CP67-412	173	18	89	1	33	0	22	0	38
L65-069	CP57-614	223	6	19	0	10	0	22	0	38
L65-069	L65-069	129	13	87	7	97	1	80	0	38
L75-002	L78-063	77	3	31	0	10	0	22	0	38
L75-002	CP77-310	642	54	77	18	85	5	80	2	88
L75-002	85P2	69	4	54	0	10	0	22	0	38
L75-002	L75-002	33	0	3	0	10	0	22	0	38
L75-035	US80-003	461	13	20	5	50	2	63	1	85
L75-056	84P1	215	11	45	1	29	0	22	0	38
L75-056	CP66-346	197	7	27	3	64	0	22	0	38
L77-038	CP62-258	200	15	71	2	47	0	22	0	38
L77-038	CP66-346	373	34	82	6	67	0	22	0	38
L78-035	CP80-360	235	20	78	4	70	1	62	0	38
L78-035	CP62-258	620	38	58	20	89	3	68	0	38
L78-035	CP76-301	464	32	66	13	85	0	22	0	38
L78-063	L75-002	491	19	31	3	33	0	22	0	38
L79-012	CP62-258	198	40	98	8	93	3	95	1	95
L79-018	CP72-355	171	5	21	1	33	0	22	0	38
L79-018	LCP81-026	224	8	27	5	78	1	65	0	38
L79-018	CP77-414	461	11	17	6	58	0	22	0	38
L79-018	L79-018	193	0	3	0	10	0	22	0	38
L79-034	L82-107	191	22	92	2	49	0	22	0	38
L79-034	CP72-355	450	18	33	1	21	0	22	0	38
L80-002	L80-045	331	19	53	2	33	0	22	0	38
L80-002	CP62-258	178	10	52	2	52	0	22	0	38
L80-002	CP72-356	216	18	77	4	73	1	67	0	38
L80-002	CP72-355	153	2	8	1	35	0	22	0	38
L80-002	CP77-310	217	13	57	1	29	0	22	0	38
L80-002	CP76-331	302	15	44	9	87	0	22	0	38
L80-035	L78-063	250	19	71	2	39	0	22	0	38
L80-035	L75-002	709	38	49	13	72	2	53	0	38
L80-035	LCP81-030	888	127	95	35	92	7	81	1	78
L80-035	CP70-321	581	12	14	8	60	2	56	0	38
L80-038	CP62-258	183	16	79	2	51	1	72	0	38
L80-040	CP62-258	603	47	73	13	78	2	55	1	82

Table 4. Continued.

Female Parent	Male Parent	Survive[1] No.	Line 1[2] No.	Line 1[2] %ile[3]	Line 2[4] No.	Line 2[4] %ile	Increase[5] No.	Increase[5] %ile	Assign[6] No.	Assign[6] %ile
L80-043	L80-043	175	3	11	0	10	0	22	0	38
L80-045	LCP81-026	216	15	66	3	60	2	85	0	38
L81-001	CP75-1082	209	4	12	2	45	1	68	0	38
L81-001	CP67-411	203	4	13	2	47	0	22	0	38
L81-001	CP77-414	731	33	39	6	39	1	46	1	80
L81-001	CP77-310	701	53	71	20	86	2	53	0	38
L81-002	LCP81-018	186	3	10	0	10	0	22	0	38
L82-107	CP69-373	127	12	84	2	66	0	22	0	38
L82-107	L82-107	50	5	86	0	10	0	22	0	38
LCP81-005	CP76-331	65	4	59	0	10	0	22	0	38
LCP81-005	CP62-258	303	26	79	8	83	0	22	0	38
LCP81-005	CP73-351	522	16	23	5	45	1	47	0	38
LCP81-005	L75-002	225	16	68	7	88	1	64	0	38
LCP81-005	CP70-321	135	1	7	0	10	0	22	0	38
LCP81-005	LCP81-030	733	57	73	12	68	7	86	3	91
LCP81-009	CP70-321	223	4	11	1	28	1	65	0	38
LCP81-009	LCP81-030	225	8	27	2	43	1	64	1	93
LCP81-010	LCP83-133	231	23	86	1	26	0	22	0	38
LCP81-010	L80-045	185	9	42	4	78	1	72	1	96
LCP81-010	CP77-310	170	8	41	3	70	0	22	0	38
LCP81-012	CP76-301	440	18	34	3	35	0	22	0	38
LCP81-012	CP70-321	944	96	88	24	81	2	48	0	38
LCP81-012	L65-069	81	19	99	11	99	3	99	1	99
LCP81-012	CP73-351	204	11	49	4	75	2	87	1	94
LCP81-012	LCP81-030	240	27	92	6	81	3	91	1	91
LCP81-015	L65-069	568	32	52	6	50	0	22	0	38
LCP81-015	CP70-321	954	50	46	9	45	1	45	1	77
LCP81-018	CP76-331	213	0	3	0	10	0	22	0	38
LCP81-018	CP67-412	128	3	15	0	10	0	22	0	38
LCP81-018	CP70-321	451	13	21	1	21	0	22	0	38
LCP81-018	L75-002	619	38	58	3	30	0	22	0	38
LCP81-023	L65-069	668	80	93	17	81	2	54	1	82
LCP81-023	CP70-321	235	8	25	0	10	0	22	0	38
LCP82-033	CP76-301	215	13	57	3	61	1	67	0	38
LCP82-033	CP72-355	261	12	40	4	65	1	58	1	90
LCP82-033	CP67-412	115	8	67	0	10	0	22	0	38
LCP82-033	LCP81-030	286	2	7	0	10	0	22	0	38
LCP82-033	CP77-310	222	26	93	6	84	0	22	0	38
LCP82-045	LCP81-030	225	7	23	2	43	1	64	0	38
LCP82-046	LCP81-030	469	9	12	4	41	2	62	1	85
LCP82-046	CP72-355	204	17	77	4	75	2	87	0	38
LCP82-047	LCP81-030	199	5	18	2	48	2	88	1	95
LCP82-047	CP70-321	250	0	3	0	10	0	22	0	38
LCP82-047	CP69-1052	502	66	94	8	66	4	81	2	90
LCP82-057	CP70-321	87	14	97	2	79	1	90	0	38
LCP82-057	CP67-412	219	3	9	0	10	0	22	0	38
LCP82-058	CP70-321	170	18	89	2	54	2	91	1	96
LCP82-058	CP76-331	180	0	3	0	10	0	22	0	38
LCP82-058	CP69-1052	202	10	44	0	10	0	22	0	38
LCP82-064	LCP81-030	115	3	18	0	10	0	22	0	38
LCP82-064	CP76-301	126	7	52	2	66	2	95	0	38
LCP82-064	CP70-321	89	4	39	0	10	0	22	0	38
LCP82-073	LCP81-030	484	11	15	0	10	0	22	0	38
LCP82-073	CP72-355	175	4	15	0	10	0	22	0	38
LCP82-089	LCP82-089	51	1	13	0	10	0	22	0	38
LCP82-089	CP67-412	203	4	13	0	10	0	22	0	38

Table 4. Continued.

Female Parent	Male Parent	Survive[1] No.	Line 1[2] No.	Line 1[2] %ile[3]	Line 2[4] No.	Line 2[4] %ile	Increase[5] No.	Increase[5] %ile	Assign[6] No.	Assign[6] %ile
LCP82-091	CP77-407	41	0	3	0	10	0	22	0	38
LCP82-096	CP75-1082	389	21	49	1	23	0	22	0	38
LCP82-097	CP72-2086	206	8	31	1	30	0	22	0	38
LCP82-097	LCP81-030	202	13	62	3	63	1	70	0	38
LCP82-097	CP70-321	47	3	62	0	10	0	22	0	38
LCP83-129	LCP81-030	129	11	78	1	38	1	80	0	38
LCP83-154	LCP81-030	155	10	63	3	74	2	92	0	38
LCP83-163	CP77-402	210	10	42	3	62	2	86	1	94
US56-14-4	S.ROB	395	21	48	7	71	3	80	0	38
US74-090	CP73-351	243	0	3	0	10	0	22	0	38
US74-090	CP70-321	66	2	22	0	10	0	22	0	38
US77-001	CP77-414	68	6	80	1	63	0	22	0	38
US77-010	84P1	193	8	34	2	49	0	22	0	38
US77-010	US77-010	145	4	20	0	10	0	22	0	38
US77-010	CP75 1082	128	0	3	0	10	0	22	0	38
US77-011	CP70-1133	177	16	81	7	92	3	96	0	38
US77-014	CP77-310	147	18	93	8	97	2	93	0	38
US77-017	CP75-308	461	36	73	6	58	1	49	0	38
US77-017	L65-069	412	34	77	10	80	2	68	0	38
US77-017	LCP81-018	209	6	21	2	45	0	22	0	38
US77-017	LCP81-030	236	8	25	1	25	0	22	0	38
US77-017	CP77-310	149	8	49	5	90	2	93	0	38
US77-017	CP70-321	999	66	64	13	58	6	74	1	77
US77-017	CP70-321	869	53	58	10	53	3	56	1	78
US79-010	CP70-1133	228	17	71	6	82	2	84	2	98
US79-011	CP78-304	515	44	78	6	54	3	74	0	38
US79-013	CP70-1133	142	6	36	1	36	1	78	0	38
US80-002	CP79-318	241	2	7	2	40	1	61	0	38
US80-004	CP72-355	239	19	74	8	89	2	82	1	92
US80-005	CP70-1133	242	18	70	1	25	0	22	0	38
US80-009	CP78-304	140	2	9	1	36	0	22	0	38
US80-010	CP70-1133	240	8	25	2	40	1	61	0	38
US80-023	CP62-258	145	1	7	0	10	0	22	0	38
US80-023	CP72-355	122	3	18	2	68	0	22	0	38
US80-024	CP79-327	94	7	70	4	94	1	88	0	38
US80-027	CP70-1133	213	20	84	6	86	0	22	0	38
US80-028	CP78-304	229	4	11	0	10	0	22	0	38
US81-002	CP81-338	250	8	24	2	39	0	22	0	38

[1] Survived is the number of individuals that survived the transplanting process.
[2] Line 1 is the number of individuals that were advanced to the first line trials.
[3] Rank percentile is based upon the percent of the survived that were advanced to the respective stage.
[4] Line 2 is the number of individuals that were advanced to the second line trials.
[5] Increase is the number of individuals that were advanced to the increase stage.
[6] Assign is the number of individuals that were advanced to the number assignment stage.

Table 5. Advancement summary of the 1986 crossing series that were advanced to the increase stage based upon the percent advancement from survived to the increase stage.

Female	Male	Survived[1]	Line 1[2]		Line 2[4]		Increase[6]	
Parent	Parent	No.	No.	%ile[3]	No.	%ile	No.	%ile
CP48-103	L83-194	243	7	29	4	68	2	85
CP61-037	CP69-1052	174	7	44	2	55	2	90
CP61-037	CP82-520	77	8	91	3	95	1	94
CP65-357	CP76-331	236	25	92	8	92	3	92
CP65-357	CP80-323	245	28	93	4	67	2	85
CP65-357	CP83-657	213	7	35	2	53	2	88
CP65-357	CP62-258	368	17	54	12	90	3	84
CP65-357	LCP81-010	234	25	.	10	.	5	.
CP65-357	LCP81-030	1222	26	.	9	.	6	.
CP65-357	LCP82-089	300	70	.	20	.	6	.
CP70-300	L84-261	486	0	3	0	10	0	27
CP70-300	LCP81-030	229	0	3	0	10	0	27
CP70-321	CP79-318	253	0	3	0	10	0	27
CP70-321	CP66-346	182	13	77	7	94	3	96
CP70-330	LCP85-336	493	0	3	0	10	0	27
CP70-330	CP85-800	218	0	3	0	10	0	27
CP70-330	CP83-644	484	0	3	0	10	0	27
CP70-330	CP86-929	161	0	3	0	10	0	27
CP70-330	L75-002	343	0	3	0	10	0	27
CP70-330	L84-290	438	0	3	0	10	0	27
CP70-330	LCP86-450	248	0	3	0	10	0	27
CP70-330	CP80-329	303	0	3	0	10	0	27
CP70-330	CP79-318	476	0	3	0	10	0	27
CP70-330	CP76-331	430	0	3	0	10	0	27
CP72-355	LCP81-030	500	3	14	0	10	0	27
CP72-355	CP77-407	174	2	9	0	10	0	27
CP72-355	86P2	476	2	16	0	10	0	27
CP72-355	CP77-310	778	50	70	18	81	6	81
CP72-355	86P2	232	29	96	10	96	2	87
CP72-356	CP77-407	157	4	16	0	10	0	27
CP72-370	CP62-258	381	5	17	0	10	0	27
CP72-370	CP79-348	195	5	20	0	10	0	27
CP72-370	L75-002	196	2	20	0	10	0	27
CP72-370	LCP86-393	240	5	20	0	10	0	27
CP72-370	LCP81-030	156	13	81	6	94	2	93
CP72-370	L65-069	330	10	31	4	58	2	78
CP72-1312	LCP82-047	250	1	7	0	10	0	27
CP72-1312	CP74-383	219	0	3	0	10	0	27
CP72-1312	LCP85-336	170	1	7	0	10	0	27
CP72-1312	89P2	216	2	8	0	10	0	27
CP72-1312	CP80-323	205	1	7	0	10	0	27
CP72-1312	86P7	163	8	58	5	88	1	79
CP72-1312	89P3	192	1	8	0	10	0	27
CP72-2086	CP72-2086	492	2	9	0	10	0	27
CP73-340	86P1	250	4	23	0	10	0	27
CP73-340	86P1	220	30	96	15	99	10	99
CP73-343	89P3	249	26	23	0	10	0	27
CP73-345	CP77-407	420	37	83	15	92	8	97
CP73-345	LCP81-030	411	6	29	0	10	0	27
CP73-345	US77-017	220	6	32	0	10	0	27
CP73-345	CP78-304	207	6	24	0	10	0	27
CP74-328	CP73-351	175	7	44	2	54	1	77
CP74-383	L83-194	382	8	41	0	10	0	27
CP74-383	L83-194	245	22	84	8	90	4	95
CP74-383	LCP86-457	154	7	34	0	10	0	27
CP74-383	CP83-644	435	2	32	0	10	0	27
CP74-383	LCP81-030	452	8	34	0	10	0	27

Table 5. Continued.

Female Parent	Male Parent	Survived[1] No.	Line 1[2] No.	Line 1[2] %ile[3]	Line 2[4] No.	Line 2[4] %ile	Increase[5] No.	Increase[5] %ile
CP75-330	CP75-1082	188	10	51	0	10	0	27
CP75-361	LCP81-030	250	12	56	0	10	0	27
CP75-361	CP73-343	363	9	51	0	10	0	27
CP75-1082	CP80-313	162	8	44	0	10	0	27
CP75-1082	89P4	70	10	47	0	10	0	27
CP76-301	CP71-441	635	8	58	0	10	0	27
CP76-351	LCP81-030	635	12	61	0	10	0	27
CP77-310	LCP85-341	196	28	94	0	10	0	27
CP77-310	89P2	232	2	6	1	21	0	27
CP77-310	CP70-330	208	6	61	0	10	0	27
CP77-310	LCP81-010	241	14	64	0	10	0	27
CP77-310	LCP81-030	226	2	88	0	10	0	27
CP77-310	LCP81-026	230	17	84	0	10	0	27
CP77-405	89P2	172	16	52	1	23	0	27
CP77-405	CP81-2149	240	13	32	1	23	0	27
CP77-405	89P3	177	39	55	3	24	0	27
CP77-405	CP77-405	211	10	20	1	22	0	27
CP77-407	CP72-1312	238	20	80	1	25	0	27
CP77-407	86P4	253	11	51	4	65	2	82
CP78-317	LCP81-030	1537	95	67	37	82	17	90
CP78-317	CP73-343	235	48	99	27	99	7	98
CP78-317	CP76-331	249	47	98	9	92	3	91
CP78-317	L75-056	198	13	72	5	84	2	89
CP78-317	LCP85-336	367	22	83	1	25	0	27
CP78-357	86P3	237	17	78	6	84	2	86
CP79-301	CP69-373	475	30	68	15	89	3	79
CP79-318	LCP86-457	237	11	55	1	29	0	27
CP79-318	LCP85-371	905	10	51	1	29	0	27
CP79-318	LCP83-126	325	24	90	1	28	0	27
CP79-318	LCP82-089	402	15	70	1	28	0	27
CP79-318	LCP81-010	246	9	41	1	28	0	27
CP79-318	LCP82-089	252	29	94	8	89	2	82
CP79-318	LCP83-126	239	20	82	9	93	2	86
CP79-318	89P4	238	16	76	1	30	0	27
CP79-318	CP73-343	753	4	14	1	26	0	27
CP79-318	US77-010	494	8	39	1	30	0	27
CP79-318	LCP81-030	657	38	65	9	63	4	78
CP79-332	CP80-352	235	5	22	1	32	0	27
CP79-332	LCP85-336	432	13	67	1	32	0	27
CP79-332	LCP82-089	253	10	44	6	81	2	82
CP79-332	CP75-308	1102	53	56	18	67	7	80
CP79-348	LCP85-336	242	4	17	1	34	0	27
CP79-348	CP70-330	212	15	10	6	33	0	27
CP79-348	CP79-348	236	6	29	1	33	0	27
CP80-313	LCP85-384	224	7	42	1	35	0	27
CP80-313	CP70-321	639	7	39	1	34	0	27
CP80-313	L77-038	205	12	66	4	75	2	88
CP80-323	CP77-407	179	21	64	2	35	0	27
CP80-329	LCP81-030	168	10	67	2	56	1	78
CP80-352	LCP82-047	231	11	72	1	36	0	27
CP80-352	CP72-1312	202	2	12	1	36	0	27
CP80-352	89P2	233	5	42	1	39	0	27
CP80-352	CP74-383	233	7	49	1	36	0	27
CP80-352	LCP86-435	214	19	97	1	37	0	27
CP80-352	89P3	185	3	10	2	40	0	27
CP80-352	LCP85-341	207	4	27	1	37	0	27

Table 5. Continued.

Female Parent	Male Parent	Survived[1] No.	Line 1[2] No.	Line 1[2] %ile[3]	Line 2[4] No.	Line 2[4] %ile	Increase[5] No.	Increase[5] %ile
CP80-356	CP80-356	242	23	85	2	40	0	27
CP81-010	CP82-089	1196	3	10	2	41	0	27
CP81-332	LCP81-010	291	14	65	2	43	0	27
CP81-2062	LCP85-336	242	10	44	2	41	0	27
CP81-2149	89P2	252	12	58	2	43	0	27
CP82-519	86P2	377	46	98	2	43	0	27
CP82-519	86P6	164	15	85	9	97	6	99
CP82-527	CP80-323	248	17	75	5	78	3	92
CP82-550	CP86-969	185	6	26	2	48	0	27
CP82-550	CP73-343	194	23	88	2	44	0	27
CP82-550	CP77-310	238	6	26	2	47	0	27
CP82-551	LCP85-336	727	4	15	2	49	0	27
CP82-551	CP85-861	247	7	31	2	48	0	27
CP82-559	CP72-355	234	6	26	2	49	0	27
CP82-559	CP80-323	249	16	70	6	82	2	83
CP83-626	CP82-520	123	9	44	2	50	0	27
CP83-626	CP82-520	142	17	95	7	96	2	94
CP83-626	86P6	202	12	66	6	87	2	89
CP83-644	LCP86-393	205	5	22	2	51	0	27
CP83-644	CP74-383	368	11	58	2	50	0	27
CP83-644	L84-261	927	9	47	2	51	0	27
CP83-644	L84-261	172	16	86	7	95	2	91
CP85-803	LCP82-047	245	12	62	2	51	0	27
CP85-845	CP76-331	216	64	99	2	53	0	27
CP85-845	LCP85-341	221	11	49	3	55	0	27
CP85-859	CP73-343	180	9	62	2	57	0	27
CP85-860	89P1	223	38	97	3	57	0	27
CP85-861	CP85-861	216	6	39	2	58	0	27
CP85-866	CP73-343	194	21	83	3	60	0	27
CP86-901	CP77-310	237	11	77	2	61	0	27
CP86-915	CP73-343	233	6	44	2	62	0	27
CP86-915	CP75-330	221	20	85	3	64	0	27
CP86-916	89P1	226	7	29	4	69	0	27
CP86-917	LCP82-047	254	6	26	4	70	0	27
CP86-921	CP80-323	175	9	79	2	71	0	27
CP86-927	CP73-343	235	30	96	4	71	0	27
CP86-936	CP80-329	240	22	88	4	73	0	27
CP86-936	CP70-330	177	7	49	3	73	0	27
CP86-939	CP72-370	245	11	91	2	73	0	27
CP86-946	CP73-343	216	14	63	5	75	0	27
CP86-947	89P1	235	24	87	5	76	0	27
CP86-950	CP80-323	228	13	71	4	77	0	27
CP86-974	CP73-343	209	14	76	4	77	0	27
COLD TOL	LCP81-030	139	13	86	7	97	2	95
L75-002	LCP81-010	214	6	26	2	47	1	70
L75-002	CP77-310	1166	17	78	2	46	1	69
L78-063	86P4	246	12	58	4	67	2	84
L78-063	87P2	236	8	36	4	71	1	70
L80-035	L75-002	939	46	58	21	80	6	80
L80-035	LCP81-030	399	17	51	6	64	4	89
L83-194	CP81-311	645	5	21	2	49	1	71
L84-290	89P3	237	14	68	1	30	1	73
L84-290	89P2	177	15	73	5	80	1	72
L84-290	89P4	249	3	13	3	63	1	73
L84-290	LCP82-047	237	17	78	6	85	1	71
L84-290	US77-017	248	7	32	4	72	1	72

Table 5. Continued.

Female Parent	Male Parent	Survived[1] No.	Line 1[2] No.	Line 1[2] %ile[3]	Line 2[4] No.	Line 2[4] %ile	Increase[5] No.	Increase[5] %ile
L84-290	CP83-644	726	8	37	3	62	1	71
LCP81-005	CP75-361	248	15	68	5	79	0	27
LCP81-005	LCP81-030	475	7	49	4	82	0	27
LCP81-010	LCP82-089	231	27	94	13	98	5	97
LCP81-010	CP76-331	227	16	76	13	98	7	98
LCP81-010	CP72-355	242	11	53	7	86	4	96
LCP81-010	LCP82-089	1904	23	90	6	85	0	27
LCP81-010	CP67-412	224	16	73	6	83	0	27
LCP81-010	LCP85-336	494	12	64	6	86	0	27
LCP81-010	89P2	195	31	27	9	39	1	54
LCP81-010	CP76-331	619	16	80	5	83	0	27
LCP81-010	LCP85-341	213	13	73	6	89	0	27
LCP81-030	LCP86-457	163	32	40	10	55	1	55
LCP81-030	CP72-355	216	38	35	9	39	1	54
LCP82-033	CP78-317	234	44	58	11	58	1	55
LCP82-046	CP48-103	544	15	10	6	32	2	56
LCP82-046	CP76-331	447	40	62	6	41	1	56
LCP82-046	LCP81-030	565	16	28	1	22	1	57
LCP82-047	89P2	670	23	17	10	47	2	57
LCP82-047	LCP81-030	720	18	34	4	37	1	57
LCP82-089	89P4	215	14	40	3	40	1	58
LCP82-089	86P5	153	2	12	2	61	1	81
LCP82-094	86P4	243	12	58	4	68	2	85
LCP83-135	LCP81-030	232	22	87	7	87	2	87
LCP83-140	CP77-402	239	18	79	8	91	3	92
LCP83-163	CP77-402	244	42	44	18	71	3	58
LCP83-165	LCP83-135	242	16	72	8	91	4	96
LCP83-179	LCP81-030	248	28	92	5	78	2	83
LCP84-214	CP80-323	226	20	37	11	74	2	59
LCP84-222	86P6	154	7	53	3	75	2	94
LCP85-307	LCP85-336	239	17	73	5	76	1	59
LCP85-336	LCP85-336	208	5	17	1	25	1	60
LCP85-384	CP75-1082	469	9	39	1	25	1	60
LCP85-384	LCP81-030	490	25	90	9	93	1	62
LCP85-384	LCP82-089	935	8	35	1	26	1	63
LCP85-384	CP76-331	212	4	14	2	41	1	61
LCP85-384	CP80-323	471	5	17	4	67	1	62
LCP85-384	LCP85-341	470	3	10	2	43	1	63
LCP85-384	CP86-924	226	20	81	5	78	1	62
LCP85-384	CP77-310	247	16	71	4	66	1	61
LCP86-393	CP72-370	230	5	20	1	26	1	64
LCP86-393	CP73-343	238	8	35	3	58	1	64
LCP86-412	CP73-343	481	10	47	3	59	1	64
LCP86-422	CP80-313	394	27	92	2	44	1	65
LCP86-422	CP77-407	228	5	20	1	28	1	65
LCP86-429	CP80-313	428	3	12	2	45	1	66
LCP86-450	LCP82-089	242	12	60	5	79	1	66
LCP86-453	CP80-329	167	16	75	3	60	1	67
LCP86-453	CP74-383	245	29	95	10	96	1	66
LCP86-453	CP77-405	451	11	54	3	60	1	67
LCP86-454	LCP82-089	430	11	54	4	69	1	67
LCP86-456	CP75-1082	221	6	24	6	85	1	68
LCP86-456	CP77-310	164	6	26	2	46	1	69
US74-090	CP78-317	237	22	89	1	32	1	74
US77-017	CP62-258	193	9	47	3	64	1	74
US77-017	CP77-310	239	8	40	2	52	1	75

Table 5. Continued.

Female Parent	Male Parent	Survived[1] No.	Line 1[2] No.	Line 1[2] %ile[3]	Line 2[4] No.	Line 2[4] %ile	Increase[5] No.	Increase[5] %ile
US77-017	US77-017	249	9	52	4	74	1	75
US77-017	LCP85-336	520	6	31	3	65	1	75
US78-026	89P1	241	7	39	2	54	1	76
US80-004	CP70-330	194	17	82	6	88	1	76
US86-002	CP73-343	243	10	17	5	53	3	77

[1] Survived is the number of individuals that survived the transplanting process.
[2] Line 1 is the number of individuals that were advanced to the first line trials.
[3] Rank percentile is based upon the percent of the survived that were advanced to the respective stage.
[4] Line 2 is the number of individuals that were advanced to the second line trials.
[5] Increase is the number of individuals that were advanced to the increase stage.

Table 6. Advancement summary of the 1987 crossing series that were advanced to the second line trial based upon the percent advancement from survived to line 2.

Female Parent	Male Parent	Survived[1] No.	Line 1[2] No.	Line 1[2] %ile[3]	Line 2[4] No.	Line 2[4] %ile
CP48-103	CP62-258	339	24	84	3	70
CP48-103	CP77-310	459	17	59	5	75
CP52-068	LCP81-030	821	27	53	5	61
CP52-068	CP62-258	1331	33	42	17	78
CP52-068	LCP85-371	245	15	79	4	85
CP52-068	CP75-308	108	5	67	0	20
CP53-018	CP77-310	504	14	48	1	43
CP57-614	87P1	175	0	10	0	20
CP61-037	CP67-412	205	16	89	3	81
CP61-037	LCP81-010	244	6	42	0	20
CP62-374	US86-006	84	0	10	0	20
CP62-374	US86-003	115	0	10	0	20
CP62-374	US86-016	104	0	10	0	20
CP65-357	LCP81-030	1003	57	76	15	83
CP65-357	CP77-402	1799	52	50	20	75
CP65-357	CP69-373	406	0	10	0	20
CP65-357	US86-016	142	0	10	0	20
CP70-300	CP72-355	.	1	.	0	.
CP70-300	CP75-1082	256	1	21	0	20
CP70-300	L78-063	454	7	31	3	62
CP70-300	US77-010	1313	11	24	5	47
CP70-300	L84-261	237	8	54	3	77
CP70-321	CP73-343	144	5	56	1	64
CP70-330	CP77-402	230	19	92	2	69
CP70-330	LCP82-046	74	3	64	0	20
CP70-330	CP77-407	362	16	66	6	87
CP70-330	CP76-301	248	4	33	0	20
CP70-330	CP80-329	289	15	71	2	64
CP70-330	CP69-1052	565	7	30	3	60
CP70-330	CP67-412	101	0	10	0	20
CP71-357	L78-035	243	17	83	7	94
CP71-447	CP76-301	650	7	29	2	46
CP71-1086	L65-069	964	10	27	1	41
CP71-1194	CP72-355	914	14	31	3	47
CP71-1194	CP62-258	940	26	48	14	82
CP71-1240	CP72-355	688	9	30	2	46
CP72-355	CP67-412	236	21	93	8	97
CP72-355	CP72-355	236	10	65	1	51
CP72-355	CP67-412	216	6	48	1	58
CP72-370	US86-003	87	0	10	0	20
CP72-370	L84-262	203	19	95	4	89
CP72-370	L65-069	239	1	21	0	20
CP72-1210	CP73-343	241	0	10	0	20
CP73-340	CP80-323	250	12	68	2	66
CP73-343	CP77-402	240	0	10	0	20
CP73-345	CP48-103	239	6	42	1	51
CP73-345	CP75-1091	178	2	29	0	20
CP73-345	CP55-038	250	13	71	0	20
CP74-383	CP48-103	448	11	42	1	44
CP74-383	LCP82-089	231	17	87	3	79
CP74-383	87P2	212	8	60	0	20
CP74-383	CP79-318	239	8	53	1	51
CP74-383	L84-264	252	7	48	1	49
CP74-383	CP82-537	234	14	78	3	78
CP74-383	LCP85-313	223	21	95	8	98
CP74-383	LCP81-030	460	27	77	14	95

Table 6. Continued.

Female Parent	Male Parent	Survived[1] No.	Line 1[2] No.	Line 1[2] %ile[3]	Line 2[4] No.	Line 2[4] %ile
CP74-383	CP72-1210	.	6	.	0	.
CP74-383	CP57-614	.	11	.	1	.
CP75-308	CP69-1052	229	4	33	0	20
CP75-327	CP67-412	452	22	69	6	80
CP75-327	US82-031	89	8	94	2	92
CP75-327	CP77-402	1661	67	62	23	81
CP75-327	L75-056	231	8	56	0	20
CP75-361	LCP81-030	247	25	96	1	49
CP75-1082	CP57-1082	444	3	23	0	20
CP75-1082	87P3	209	19	94	5	92
CP75-1082	CP75-1082	660	7	29	1	42
CP75-1091	CP75-1091	242	0	10	0	20
CP75-1322	CP77-310	1032	42	64	9	69
CP76-301	CP76-301	226	8	56	1	56
CP77-402	L65-069	944	7	23	2	44
CP77-405	LCP82-089	240	13	73	6	94
CP77-405	LCP84-257	243	7	50	0	20
CP77-405	LCP83-151	195	7	58	2	74
CP77-405	CP77-405	149	1	23	0	20
CP77-405	CP76-331	230	5	40	2	69
CP77-405	L84-261	171	0	10	0	20
CP77-407	87P3	194	7	58	4	90
CP77-413	85P1	254	8	51	2	65
CP78-357	CP75-308	469	30	80	7	82
CP78-357	L75-002	248	12	68	5	90
CP78-317	CP62-258	234	5	39	0	20
CP78-317	LCP81-030	308	12	61	3	73
CP79-318	CP62-258	1200	22	34	8	63
CP79-318	LCP85-371	453	38	93	3	62
CP79-318	CP73-343	243	17	83	2	67
CP79-318	87P1	162	3	36	0	20
CP79-318	L75-056	250	1	21	0	20
CP79-318	CP70-321	244	6	42	3	77
CP79-318	L84-264	705	26	59	1	42
CP79-318	US86-006	142	0	10	0	20
CP79-318	US86-016	109	0	10	0	20
CP79-318	US77-010	228	11	68	4	88
CP79-318	CP69-1052	462	14	50	0	20
CP79-318	US86-004	143	0	10	0	20
CP79-332	US86-003	142	0	10	0	20
CP79-332	L78-035	204	14	82	0	20
CP79-332	CP77-310	464	22	67	7	83
CP79-332	CP76-331	451	17	60	10	91
CP79-332	US86-016	118	0	10	0	20
CP79-332	US82-031	201	4	37	1	59
CP79-332	CP86-978	132	7	72	2	84
CP79-348	LCP83-172	236	9	60	3	77
CP80-313	CP69-373	384	2	22	1	45
CP80-313	CP70-321	241	2	24	0	20
CP80-313	LCP81-030	458	25	74	1	44
CP80-313	CP80-323	109	0	10	0	20
CP80-319	CP69-1052	182	6	53	0	20
CP80-323	CP73-351	232	6	45	2	68
CP80-323	CP71-459	222	2	26	0	20
CP80-323	CP77-402	238	0	10	0	20
CP80-328	CP72-355	223	7	51	1	57

Table 6. Continued.

Female Parent	Male Parent	Survived[1] No.	Line 1[2] No.	Line 1[2] %ile[3]	Line 2[4] No.	Line 2[4] %ile
CP80-328	L77-038	150	9	78	0	20
CP80-351	CP66-346	397	13	53	4	74
CP80-351	LCP81-030	936	33	56	4	54
CP80-351	CP76-301	520	34	81	1	43
CP80-352	CP80-313	228	6	45	1	56
CP80-352	CP72-355	212	6	48	2	72
CP80-352	CP73-343	235	5	39	1	54
CP80-352	CP76-301	651	10	31	4	61
CP80-356	CP78-403	246	13	72	3	76
CP81-010	LCP83-133	928	19	37	4	54
CP81-325	LCP85-385	217	7	52	0	20
CP81-329	86P3	.	6	.	4	.
CP81-332	LCP81-010	428	34	90	13	95
CP81-332	CP76-331	.	13	.	6	.
CP81-332	US86-013	142	0	10	0	20
CP81-338	LCP81-030	514	29	75	16	97
CP81-338	CP76-301	1230	102	92	38	96
CP82-550	US82-044	99	0	10	0	20
CP82-550	US77-010	148	4	46	1	63
CP83-606	LCP82-058	247	15	79	0	20
CP83-631	LCP82-089	215	16	87	2	72
CP83-632	L78-035	100	5	70	2	89
CP85-860	CP76-331	79	0	10	0	20
CP85-866	US82-031	166	0	10	0	20
L65-069	CP67-412	62	0	10	0	20
L78-035	L78-035	236	0	10	0	20
L78-035	CP62-258	660	11	33	5	64
L78-063	87P1	253	8	52	2	65
L78-063	87P2	198	15	89	3	84
L79-034	L82-107	254	9	56	0	20
L80-035	CP72-355	245	6	41	0	20
L80-035	LCP81-030	105	0	10	0	20
L80-038	CP62-258	239	26	97	1	51
L82-107	CP69-373	248	10	62	6	93
L82-107	L82-107	444	5	29	0	20
L84-262	L84-262	138	0	10	0	20
L84-276	CP72-355	195	8	64	1	59
L85-294	L78-035	216	6	48	2	72
LCP81-005	LCP81-030	334	5	31	0	20
LCP81-005	L75-056	244	16	81	1	50
LCP81-005	CP62-258	973	67	82	24	93
LCP81-010	US82-044	103	2	36	0	20
LCP81-010	CP77-410	249	18	86	1	49
LCP81-010	CP67-412	212	16	88	1	58
LCP81-010	L84-261	226	9	62	3	80
LCP81-010	CP82-513	146	0	10	0	20
LCP81-010	CP73-343	246	14	76	2	67
LCP81-023	CP70-321	.	7	.	1	.
LCP82-033	CP77-310	194	5	45	1	60
LCP82-046	CP48-103	164	10	79	0	20
LCP82-046	CP72-355	193	10	71	0	20
LCP82-046	CP76-331	202	22	97	0	20
LCP82-046	LCP81-030	251	5	37	1	49
LCP82-046	CP57-614	211	12	76	3	81
LCP82-046	87P3	203	10	69	2	73
LCP82-046	LCP82-046	.	2	.	1	.

Table 6. Continued.

Female Parent	Male Parent	Survived[1] No.	Line 1[2] No.	Line 1[2] %ile[3]	Line 2[4] No.	Line 2[4] %ile
LCP82-046	87P1	109	4	59	2	88
LCP82-047	CP69-1052	402	22	74	1	45
LCP82-047	LCP82-047	154	3	36	0	20
LCP82-057	CP70-321	462	10	40	2	54
LCP82-058	LCP82-058	111	2	34	0	20
LCP82-073	LCP85-371	100	12	99	2	89
LCP83-137	CP80-323	233	10	65	4	87
LCP83-153	LCP81-030	222	27	99	5	92
LCP84-200	CP75-1082	222	0	10	0	20
LCP84-212	87P2	256	5	37	3	76
LCP84-214	CP80-323	79	2	42	0	20
LCP84-215	LCP81-030	232	17	87	7	95
LCP84-215	L75-056	109	6	74	0	20
LCP85-385	LCP85-385	98	0	10	0	20
US77-010	LCP82-047	239	26	97	11	99
US77-017	L65-069	243	10	64	1	50
US82-010	US82-044	89	6	81	4	98
US82-010	CP82-513	88	10	98	4	99
US83-036	LCP82-046	85	0	10	0	20
US86-002	CP83-659	141	0	10	0	20
US86-002	CP73-351	103	0	10	0	20
US86-004	CP82-520	100	0	10	0	20
US86-004	CP73-351	147	0	10	0	20
US86-004	CP79-318	109	0	10	0	20
US86-008	CP80-323	91	0	10	0	20
US86-008	CP81-332	89	0	10	0	20
US86-009	CP81-332	145	0	10	0	20
US86-011	CP72-370	120	0	10	0	20
US86-011	CP73-351	77	0	10	0	20
US86-014	CP83-637	136	0	10	0	20
US86-015	CP83-637	134	0	10	0	20
US86-974	US86-003	113	0	10	0	20

[1] Survived is the number of individuals that survived the transplanting process.
[2] Line 1 is the number of individuals that were advanced to the first line trials.
[3] Rank percentile is based upon the percent of the survived that were advanced to the respective stage.
[4] Line 2 is the number of individuals that were advanced to the second line trials.

Table 7. Advancement summary of the 1988 crossing series that were advanced to the first line trial based upon the percent advancement from survived to line 1.

Female Parent	Male Parent	Survived[1] No.	Line 1[2] No.	Line 1[2] %ile[3]
CP48-103	CP77-310	189	7	36
CP48-103	CP67-412	225	7	30
CP48-103	L84-275	92	1	11
CP48-103	CP72-1312	229	11	46
CP52-068	LCP81-030	751	75	72
CP61-037	L84-275	192	15	62
CP61-037	CP78-304	425	18	40
CP61-037	CP72-2086	81	12	89
CP61-037	CP68-1026	217	7	31
CP61-037	CP74-1094	203	11	49
CP61-037	L84-290	191	1	5
CP61-037	CP84-722	186	12	53
CP65-357	CP72-2086	181	22	81
CP65-357	CP69-373		9	
CP65-357	CP77-402	552	30	49
CP65-357	CP62-258	1302	79	50
CP65-357	CP75-1082	199	9	43
CP65-357	LCP81-030	683	81	80
CP65-357	CP82-519	95	17	93
CP65-357	LCP85-336	442	14	31
CP65-357	CP77-407	230	46	97
CP67-412	L77-038	95	2	18
CP69-373	CP74-2013	151	2	12
CP70-300	LCP81-030	454	1	0
CP70-330	LCP81-030	657	45	55
CP70-330	CP69-1052	193	1	5
CP70-330	CP73-351	240	11	44
CP70-330	CP76-331	326	1	1
CP70-330	LCP82-047	408	49	80
CP70-1527	CP73-340	206	21	74
CP70-1527	CP77-407	442	34	61
CP71-441	CP67-412	245	25	74
CP71-441	CP80-323	90	17	94
CP71-1194	CP77-405	243	12	46
CP71-1194	L78-035	171	6	33
CP71-1240	CP72-355	217	3	13
CP72-355	CP77-414	227	5	20
CP72-355	CP77-310	132	3	21
CP72-356	LCP85-336	230	21	70
CP72-370	LCP81-010	208	9	41
CP72-370	CP62-258	331	10	28
CP72-370	L75-002	702	21	28
CP72-370	LCP82-047	215	41	95
CP72-370	LCP83-149	104	9	67
CP72-1210	L75-002	203	2	9
CP72-1210	CP77-407	217	5	21
CP72-1210	LCP82-047	196	19	71
CP72-2086	L75-002	690	26	37
CP73-340	CP57-614	236	12	47
CP73-340	CP77-310	218	14	52
CP73-343	CP73-343	100	1	9
CP73-345	CP76-331	183	7	37
CP73-345	CP62-258	769	86	78
CP73-345	CP80-329	187	2	11
CP73-345	CP74-1094	225	10	42
CP73-345	CP72-2086	433	54	82

Table 7. Continued.

Female Parent	Male Parent	Survived[1] No.	Line 1[2] No.	Line 1[2] %ile[3]
CP73-345	LCP82-058	231	4	15
CP73-345	CP77-407	845	18	18
CP73-345	LCP82-047	196	22	78
CP73-345	LCP82-046	68	1	15
CP73-351	CP80-323	84	9	77
CP73-351	LCP85-336	181	8	42
CP73-351	CP72-2086	193	15	62
CP74-328	CP77-405	74	1	13
CP74-383	L75-002	205	1	5
CP74-383	LCP81-030	207	40	96
CP74-383	CP78-304	200	13	53
CP74-383	CP77-310	241	22	70
CP74-383	L84-290	202	9	43
CP74-383	LCP85-336	456	70	90
CP74-383	L75-056	240	5	18
CP74-383	CP80-323	424	6	13
CP74-383	CP72-2086	228	33	88
CP74-383	CP67-412	240	7	26
CP74-383	CP75-1082	484	34	57
CP74-1094	LCP83-149	193	9	45
CP75-327	LCP85-384	462	67	88
CP75-327	LCP85-336	443	16	34
CP75-327	CP80-323	210	28	86
CP75-330	CP72-356	212	4	16
CP75-330	CP77-405	214	8	36
CP75-361	LCP85-336	654	51	62
CP75-361	L75-002	211	10	45
CP75-361	CP77-310	193	27	87
CP75-361	L77-038	241	9	36
CP75-361	CP75-1082	226	4	16
CP75-361	CP75-330	57	6	76
CP75-361	CP80-313	220	14	52
CP75-361	L84-290	221	23	75
CP75-1082	CP78-304	205	2	9
CP75-1082	CP80-329	336	7	18
CP75-1632	CP77-405	240	6	22
CP76-351	LCP84-215	197	10	47
CP76-351	CP77-402	188	1	5
CP76-351	CP83-607	184	5	24
CP76-351	CP84-755	88	7	64
CP76-351	LCP81-010	193	4	18
CP76-351	CP80-329	184	1	5
CP76-351	CP77-407	218	23	77
CP77-310	LCP81-030	210	19	69
CP77-310	CP78-304	242	25	75
CP77-310	LCP82-046	230	19	65
CP77-310	CP77-407	235	18	61
CP77-310	CP84-761	414	40	71
CP77-405	CP75-1082	223	1	2
CP77-407	CP75-1082	217	15	56
CP77-413	85P1	192	24	82
CP78-304	LCP82-089	241	3	11
CP78-304	CP72-2086	214	15	57
CP78-317	CP72-355	139	24	92
CP78-357	L84-273	91	7	61
CP78-357	LCP81-010	241	47	96

Table 7. Continued.

Female Parent	Male Parent	Survived[1] No.	Line 1[2] No.	Line 1[2] %ile[3]
CP78-357	CP77-407	183	7	37
CP78-357	CP72-2086	229	27	79
CP78-357	CP80-323	218	16	59
CP78-357	LCP81-030	238	10	40
CP79-318	CP80-323	1601	92	50
CP79-318	L84-290	208	3	13
CP79-318	CP67-412	231	7	28
CP79-318	CP77-405	202	14	56
CP79-318	CP77-402	226	15	54
CP79-318	LCP84-222	450	28	51
CP79-318	LCP85-336	436	25	50
CP79-318	LCP85-298	185	5	24
CP79-318	CP72-356	105	3	26
CP79-332	CP77-310	1493	66	42
CP79-332	CP72-370	454	44	71
CP79-332	CP72-356	231	24	75
CP79-332	CP78-357	217	41	94
CP79-332	CP84-722	234	50	98
CP79-332	L84-290	230	6	23
CP79-332	CP57-614	236	6	22
CP79-332	CP67-412	1112	98	68
CP79-348	CP73-343	228	36	91
CP79-348	CP80-323	213	30	87
CP79-348	L75-056	361	26	58
CP79-348	LCP85-384	233	44	94
CP79-348	CP57-614	197	6	28
CP79-348	LCP81-030	233	28	80
CP80-313	LCP81-030	273	17	51
CP80-313	CP69-373	424	6	13
CP80-313	CP73-343	177	5	25
CP80-323	L84-276	101	4	38
CP80-323	LCP82-047	226	38	92
CP80-323	LCP84-215	145	5	32
CP80-323	CP67-412	86	3	33
CP80-328	CP77-310	228	6	23
CP80-328	LCP83-149	198	25	83
CP80-328	CP62-258	236	24	74
CP80-328	L75-056	208	37	93
CP80-328	L84-290	218	39	93
CP80-328	CP70-321	448	58	85
CP80-328	CP75-1082	205	20	72
CP80-328	CP80-356	205	18	68
CP80-329	CP80-323	208	11	48
CP80-351	CP66-346	962	29	28
CP80-352	CP77-405	226	1	2
CP80-352	CP72-355	947	71	60
CP80-352	CP77-407	221	16	58
CP80-352	CP81-332	208	32	90
CP80-352	L84-290	188	13	56
CP80-352	CP77-310	426	23	49
CP80-356	CP80-356	164	13	63
CP81-316	L78-035	98	10	74
CP81-316	CP77-405	188	14	59
CP81-316	CP72-355	95	12	83
CP81-316	CP75-308	231	8	33
CP82-513	CP57-614	105	2	16

Table 7. Continued.

Female Parent	Male Parent	Survived[1] No.	Line 1[2] No.	Line 1[2] %ile[3]
CP82-513	CP73-343	221	6	24
CP82-550	LCP85-298	226	19	66
CP82-550	CP81-332	84	7	65
CP83-149	CP83-149	101	1	9
CP83-607	US77-009	90	12	86
CP83-607	CP57-614	227	11	46
CP83-644	LCP82-089	220	35	91
CP83-644	CP57-614	216	25	79
CP83-644	CP80-329	222	1	5
CP84-730	LCP82-047	242	67	99
L78-035	LCP82-046	225	1	2
L83-193	CP80-323	231	1	2
L84-218	CP74-383	343	3	7
L84-266	CP75-1082	230	15	53
L84-275	CP75-1082	217	9	39
L84-276	LCP81-030	224	8	34
L84-276	CP48-103	228	9	38
LCP81-005	CP74-2013	218	9	39
LCP81-005	CP84-761	223	8	34
LCP81-010	CP78-357	232	31	86
LCP81-010	LCP82-089	614	1	0
LCP81-015	CP80-323	227	18	63
LCP81-030	CP77-310	238	59	98
LCP81-030	LCP82-089	211	1	5
LCP82-033	CP73-343	217	19	68
LCP82-033	CP77-310	210	1	5
LCP82-033	CP77-402	235	7	28
LCP82-033	CP75-1082	230	6	23
LCP82-046	LCP81-030	197	6	28
LCP82-046	CP73-343	97	2	18
LCP83-154	LCP81-030	97	3	30
LCP85-307	CP76-331	89	2	20
LCP85-307	CP84-772	163	11	55
LCP85-313	LCP85-336	231	26	78
LCP85-316	CP67-412	237	19	64
LCP85-336	LCP85-336	95	1	11
LCP85-336	CP72-370	229	7	30
LCP85-352	CP73-343	195	9	44
LCP85-384	LCP85-336	411	61	89
LCP85-384	CP80-313	240	36	89
LCP85-384	CP80-329	225	48	97
LCP86-391	L83-194	101	1	9
LCP86-391	LCP82-046	79	6	60
US74-090	CP80-323	182	16	68
US77-017	CP72-356	225	59	99
US77-017	CP75-308	423	52	82
US77-017	CP80-329	215	27	83
US77-017	LCP82-047	213	18	66
US77-017	CP75-1082	203	26	84

[1] Survived is the number of individuals that survived the transplanting process.
[2] Line 1 is the number of individuals that were advanced to the first line trials.
[3] Rank percentile is based upon the percent of the survived that were advanced to Line 1.

1990 LOUISIANA (L) NURSERY VARIETY TRIALS

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Five years after the initial hybridization of parents, clones that have met or exceeded criteria for important characteristics at each selection stage are assigned permanent numbers by the Louisiana (L) Sugarcane Varietal Development Program. These new varieties are planted in replicated single row tests referred to as the "nursery" variety trials.

One of the objectives of the nursery stage of the selection program is to identify and select varieties that will perform well across the range of environments a commercial variety will probably encounter in Louisiana. To realize this objective, new varieties are planted in as many locations as possible. The locations for 1990 were: the St. Gabriel Research Station at St. Gabriel, LA, the Iberia Research Station near Jeanerette, LA, Triple V Farms near Youngsville, LA, Westfield Plantation near Paincourtville, LA, and Peebles Plantation near the Port of Iberia.

Nursery trials were planted in single row (six foot centers), 16 foot plots using two replications per location in a randomized complete block design. Three commercial check varieties (CP65-357, CP70-321, and CP74-383) were included in all tests. The commercial varieties establish the norm that the new varieties are expected to meet or exceed.

Stalk counts were made in August and September. During the normal harvest season, ten-stalk samples were harvested by hand for stalk weight and juice analysis. Brix was measured by refractometer and sucrose by polarization. Theoretical recoverable sugar (reported as sucrose content) was calculated according to the methods described by Legendre and Henderson (1972). Fiber estimates were made using a four-stalk sample and the chip press method (Tanimoto, 1964). Cane yield was estimated as the product of stalk weight and stalk number. Sucrose yield was calculated as the product of sucrose content and cane yield.

Analysis of variance was performed for each assignment series, crop and location-soil texture combination. A combined analysis was performed over locations-soil texture for each crop and assignment series. Minimum significant differences (MSD) were calculated by the Waller-Duncan multiple range test (SAS,1985).

A record freeze in December, 1989, severely damaged most tests. The damage was amplified by the extraordinary amount of rain that fell during January and February, 1990. As a result, varietal performances were quite variable, especially in the older ratoon crops. Because of these unusual weather events, special care should be taken in interpreting the data.

Table 1. Planting date and harvest dates of nursery tests planted or harvested in 1990.

Series	Location	Soil Texture[1]	Planting Date	Harvest Dates 1987	1988	1989	1990
1986	Iberia	B.s.c.	10/30/86	11/16	11/16	10/19	10/22
1987	Iberia	B.s.c.	10/16/87		11/16	11/16	10/22
1987	St. Gabriel	C.s.l.	10/19/87		11/29	-----	-----
1987	St. Gabriel	S.c.	10/14/87		11/29	11/06	11/08
1987	Triple V Farms	Co.s.l.	9/08/88			11/14	11/05
1987	Westfield Pltn.	S.s.c.	9/22/88			11/30	11/05
1988	Iberia	B.s.c.	10/13/88			11/16	11/05
1988	St. Gabriel	C.s.l.	10/14/88			11/30	11/08
1988	St. Gabriel	S.c.	10/07/88			11/21	11/08
1988	Peebles Pltn.	Galvez	9/19/89				11/13
1988	Westfield Pltn.	S.s.c.	10/10/89				11/13
1989	Iberia	B.s.c.	10/19/89				11/27
1989	St. Gabriel	C.s.l.	10/25/89				12/10
1989	St. Gabriel	S.c.	10/24/89				12/10
1989	Peebles Pltn.	Galvez	10/11/90				
1989	Westfield Pltn.	S.s.c.	10/29/90				
1990	Iberia	B.s.c.	10/17/90				
1990	St. Gabriel	C.s.l.	10/18/90				
1990	St. Gabriel	S.c.	10/16/90				

[1]B.s.c. - Baldwin silty clay; C.s.l. - Commerce silt loam; S.c. - Sharkey clay; S.s.c. - Sharkey silty clay; Co.s.l. - Coteau silt loam; Galvez - Galvez silt loam.

References

Legendre, B. L. and M. T. Henderson. 1972. The history and development of sugar yield calculations. Proc. Am. Soc. Sugar Cane Technol. 2(ns): 10-18.

SAS Institute Inc. SAS User's Guide: Statistics, Ver. 5 ed. Cary, NC: SAS Institute Inc., 1985 956pp.

Tanimoto, T. 1964. The press method of cane analysis. Hawaiian Planter's Record. 57(2): 133-150.

Table 2. 1990 third ratoon means of the 1986 "L" series at the Iberia Research Station.

Variety	Sucrose yield	Cane yield	Stalk number	Stalk weight	Sucrose content
	lbs/A	tons/A	no./A	lbs	lbs/ton
CP65-357	496	3.1	4991	1.23	160
CP70-321	3149	18.9	18604	2.03	169
CP74-383	4310	27.7	32897	1.69	156
LCP86-408	3744	22.8	26091	1.78	166
LCP86-420	2532	15.6	18150	1.75	158
LCP86-429	5060	30.3	27679	2.19	167
LCP86-454	2480	16.0	21326	1.50	155
$MSD_{.05}$	NS	NS	32999	.85	NS

Table 3. 1990 second ratoon means of the 1987 "L" series.

Variety	Sucrose yield	Cane yield	Stalk number	Stalk weight	Sucrose content
	lbs/A	tons/A	no./A	lbs	lbs/ton
CP65-357	2019	9.3	10550	1.60	209
CP70-321	2179	9.7	11458	1.65	229
CP74-383	2747	15.0	17129	1.68	209
LCP87-017	5886	27.4	30515	1.74	220
LCP87-023	3093	14.0	19663	1.39	216
LCP87-472	4177	22.0	27225	1.49	197
LCP87-479	4493	24.3	33691	1.43	187
LCP87-491	5643	26.4	29721	1.70	223
LCP87-492	7357	33.6	46623	1.44	218
LCP87-494	4979	24.2	27112	1.63	211
LCP87-496	5410	28.1	31763	1.72	204
$MSD_{.05}$	3639	19.2	16270	NS	40

Table 4. 1990 second ratoon means of the 1987 "L" series at the Iberia Research Station.

Variety	Sucrose yield	Cane yield	Stalk number	Stalk weight	Sucrose content
	lbs/A	tons/A	no./A	lbs	lbs/ton
CP65-357	1923	9.1	11798	1.52	202
CP70-321	2310	11.7	13386	1.68	191
CP74-383	4779	27.0	31082	1.72	184
LCP87-017	6345	32.9	36074	1.72	191
LCP87-023	2774	13.6	19512	1.33	200
LCP87-472	5527	34.5	38115	1.81	160
LCP87-479	5724	31.6	41518	1.52	182
LCP87-491	7018	35.8	39477	1.82	196
LCP87-492	6348	32.0	44922	1.43	197
LCP87-494	6842	35.3	34485	1.93	184
LCP87-496	6865	39.2	41745	1.88	175
$MSD_{.05}$	6546	32.8	22315	.82	NS

Table 5. 1990 second ratoon means of the 1987 "L" series at the St. Gabriel Research Station on a Sharkey clay.

Variety	Sucrose yield	Cane yield	Stalk number	Stalk weight	Sucrose content
	lbs/A	tons/A	no./A	lbs	lbs/ton
CP65-357	2115	9.5	9302	1.68	215
CP70-321	2049	7.7	9529	1.62	266
CP74-383	715	3.1	3177	1.64	235
LCP87-017	5427	21.9	24957	1.76	248
LCP87-023	3731	15.0	19965	1.50	249
LCP87-472	3502	15.8	21781	1.33	215
LCP87-479	3263	17.0	25864	1.34	192
LCP87-491	4268	17.0	19966	1.58	250
LCP87-492	8366	35.3	48325	1.45	239
LCP87-494	3115	13.2	19738	1.34	238
LCP87-496	3956	17.0	21780	1.56	233
$MSD_{.05}$	6251	26.8	24703	NS	38

Table 6. 1990 first ratoon means of the 1987 "L" series.

Variety	Sucrose yield	Cane yield	Stalk number	Stalk weight	Sucrose content
	lbs/A	tons/A	no./A	lbs.	lbs/ton
CP65-357	3115	12.3	12025	2.10	254
CP70-321	5084	19.5	18831	2.13	257
CP74-383	6828	28.0	25750	2.03	244
LCP87-017	7185	30.0	28133	2.15	240
LCP87-023	5771	22.6	27225	1.63	255
LCP87-472	5023	23.5	23595	1.94	220
LCP87-479	7802	37.8	35393	2.13	208
LCP87-491	6614	27.8	34712	1.58	234
LCP87-492	10595	42.2	48438	1.72	251
LCP87-494	7719	32.7	28927	2.23	232
LCP87-496	6332	28.5	28019	1.93	216
$MSD_{.05}$	5348	24.6	18660	.68	28

Table 7. 1990 first ratoon means of the 1987 "L" series at Triple V Farms.

Variety	Sucrose yield	Cane yield	Stalk number	Stalk weight	Sucrose content
	lbs/A	tons/A	no./A	lbs	lbs/ton
CP70-321	3549	14.8	13159	2.24	241
CP74-383	3126	13.6	15655	1.71	237
LCP85-336	5344	21.8	19739	2.19	244
LCP85-376	5546	24.9	25184	1.97	223
LCP85-384	5997	22.5	25411	1.77	267
LCP87-017	6616	27.5	25637	2.18	240
LCP87-023	3379	13.2	17696	1.49	256
LCP87-472	6168	30.9	30175	2.04	201
LCP87-479	5895	30.4	30175	2.00	200
LCP87-491	5218	22.8	24730	1.69	224
LCP87-492	8823	34.5	44468	1.55	256
LCP87-494	5196	23.2	22234	2.13	222
LCP87-496	3723	17.6	20419	1.65	205
$MSD_{.05}$	4739	19.2	16357	.54	50

Table 8. 1990 first ratoon means of the 1987 "L" series at Westfield Plantation.

Variety	Sucrose yield	Cane yield	Stalk number	Stalk weight	Sucrose content
	lbs/A	tons/A	no./A	lbs	lbs/ton
CP65-357	3115	12.3	12025	2.10	254
CP70-321	6619	24.2	24503	2.02	273
CP74-383	10530	42.3	35846	2.35	250
LCP87-017	7755	32.5	30629	2.12	239
LCP87-023	6967	27.3	31990	1.70	254
LCP87-472	3878	16.1	17016	1.83	238
LCP87-479	9709	45.2	40611	2.26	216
LCP87-491	8011	32.8	44695	1.47	245
LCP87-492	12368	50.0	52408	1.90	247
LCP87-494	10242	42.3	35620	2.34	242
LCP87-496	8941	39.5	35620	2.21	228
$MSD_{.05}$	9131	36.4	33227	.36	13

Table 9. 1990 first ratoon means of the 1988 "L" series.

Variety	Sucrose yield	Cane yield	Stalk number	Stalk weight	Sucrose content
	lbs/A	tons/A	no./A	lbs	lbs/ton
CP65-357	5862	25.5	23595	2.08	224
CP70-321	9842	36.4	35166	2.04	268
CP74-383	8988	38.2	36981	2.00	236
L88-028	8666	33.6	26771	2.45	254
L88-030	8672	39.7	45905	1.72	216
L88-046	8125	31.7	35468	1.73	244
L88-049	8322	33.8	28435	2.37	244
L88-063	7198	31.9	36754	1.76	224
L88-066	7409	31.3	34107	1.80	229
L88-069	7245	32.2	36451	1.78	224
L88-070	8354	38.4	32065	2.38	209
L88-073	10265	40.3	42577	1.85	250
L88-075	7769	33.1	37359	1.77	234
LCP88-078	11157	44.8	42426	2.09	246
LCP88-079	9306	37.0	31687	2.35	251
LCP88-091	7866	33.4	32217	2.08	233
$MSD_{.05}$	4298	18.8	12609	.31	23

Table 10. 1990 first ratoon means of the 1988 "L" series at the Iberia Research Station.

Variety	Sucrose yield	Cane yield	Stalk number	Stalk weight	Sucrose content
	lbs/A	tons/A	no./A	lbs	lbs/ton
CP65-357	3922	19.4	22461	1.73	203
CP70-321	8238	33.0	30855	2.14	250
CP74-383	5343	22.4	23595	1.84	240
L88-028	8609	35.1	24049	2.83	241
L88-030	5135	25.3	32671	1.51	203
L88-046	4498	21.2	28587	1.47	212
L88-049	6506	28.7	25184	2.28	227
L88-063	5019	22.7	24049	1.89	221
L88-066	3686	19.5	23596	1.64	190
L88-069	6259	29.8	31763	1.87	210
L88-070	5948	31.9	24503	2.56	183
L88-073	5073	22.7	29721	1.52	219
L88-075	5461	25.0	31309	1.61	219
LCP88-078	7085	29.8	30175	1.97	238
LCP88-079	7429	32.1	27452	2.34	231
LCP88-091	5699	25.5	24503	2.08	223
$MSD_{.05}$	6775	NS	18457	.54	35

Table 11. 1990 first ratoon means of the 1988 "L" series at the St. Gabriel Research Station on a Sharkey clay.

Variety	Sucrose yield	Cane yield	Stalk number	Stalk weight	Sucrose content
	lbs/A	tons/A	no./A	lbs	lbs/ton
CP65-357	3193	14.3	14293	2.00	223
CP70-321	7052	27.3	30402	1.77	262
CP74-383	8434	37.3	40838	1.83	226
L88-028	5071	21.6	20873	2.03	239
L88-030	9347	46.6	59441	1.57	201
L88-046	6000	25.9	34485	1.51	232
L88-049	7451	33.1	30175	2.18	225
L88-063	6594	30.6	43107	1.42	217
L88-066	7609	31.0	36981	1.67	244
L88-069	6773	31.2	41745	1.50	217
L88-070	6662	35.0	34486	1.99	186
L88-073	11506	43.7	52635	1.67	263
L88-075	9990	43.6	49459	1.77	229
LCP88-078	11340	46.8	47644	1.97	242
LCP88-079	10320	42.3	38342	2.19	245
LCP88-091	7784	34.1	35620	1.93	227
$MSD_{.05}$	4492	19.7	14864	.45	29

Table 12. 1990 first ratoon means of the 1988 "L" series at the St. Gabriel Research Station on a Commerce silt loam.

Variety	Sucrose yield	Cane yield	Stalk number	Stalk weight	Sucrose content
	lbs/A	tons/A	no./A	lbs	lbs/ton
CP65-357	10473	42.8	34032	2.52	246
CP70-321	14237	49.0	44241	2.21	291
CP74-383	13188	54.8	46510	2.34	243
L88-028	12319	44.3	35393	2.48	282
L88-030	11533	47.3	45602	2.08	244
L88-046	13879	48.1	43333	2.22	289
L88-049	11009	39.5	29948	2.64	279
L88-063	9980	42.4	43106	1.97	234
L88-066	10934	43.5	41746	2.09	251
L88-069	8703	35.6	35847	1.98	244
L88-070	12454	48.2	37208	2.59	258
L88-073	14216	54.6	45376	2.37	268
L88-075	7855	30.7	31309	1.95	254
LCP88-078	15046	57.8	49459	2.32	259
LCP88-079	10170	36.5	29267	2.51	278
LCP88-091	10116	40.7	36527	2.23	249
$MSD_{.05}$	6516	29.7	10826	.84	65

Table 13. 1990 plant cane means of the 1988 "L" series.

Variety	Sucrose yield	Cane yield	Stalk number	Stalk weight	Sucrose content
	lbs/A	tons/A	no./A	lbs.	lbs/ton
CP65-357	3925	16.7	14180	2.37	226
CP70-321	8332	33.5	25410	2.77	245
CP74-383	6106	27.4	18491	2.98	226
L88-028	8947	31.7	22574	2.95	275
L88-030	5401	21.7	21327	2.04	251
L88-046	7752	31.1	27679	2.28	246
L88-049	5713	24.4	17394	2.77	235
L88-063	9115	38.5	31460	2.50	235
L88-066	9119	36.1	27792	2.63	253
L88-069	8906	38.4	26166	2.93	232
L88-070	5656	26.3	18831	2.70	209
L88-073	6978	27.2	29191	2.04	252
L88-075	7551	31.9	23482	2.60	234
LCP88-078	8161	33.4	23822	2.72	239
LCP88-079	6045	27.4	19512	3.05	220
LCP88-091	8362	34.1	22121	3.11	244
$MSD_{.05}$	NS	NS	NS	.75	31

Table 14. 1990 plant cane means of the 1988 "L" series at Peebles Plantation.

Variety	Sucrose yield	Cane yield	Stalk number	Stalk weight	Sucrose content
	lbs/A	tons/A	no./A	lbs	lbs/ton
CP65-357	3144	12.8	11117	2.35	237
CP70-321	4763	20.9	13159	3.17	228
CP74-383	6727	31.4	20192	3.14	214
LCP85-336	8087	31.8	22234	2.91	252
LCP85-376	2224	9.6	7714	2.38	231
LCP85-384	4575	20.7	15201	2.60	227
LCP86-408	3180	15.0	13613	2.17	210
LCP86-420	3735	15.8	14520	2.18	239
LCP86-454	3782	17.1	11571	3.04	227
L88-028	4908	19.0	11571	3.24	257
L88-030	5304	23.1	21100	2.20	230
L88-046	5855	26.1	21780	2.39	225
L88-049	5939	29.2	22234	2.63	203
L88-063	6945	33.5	22688	2.95	207
L88-066	9153	37.4	28133	2.66	245
L88-069	8356	40.0	25864	3.09	209
L88-070	2701	14.0	11344	2.48	193
L88-073	4486	20.4	14974	2.72	220
L88-075	7063	32.2	23142	2.73	216
LCP88-078	6469	28.6	20192	2.74	221
LCP88-079	4887	23.1	13159	3.62	214
LCP88-091	7292	32.2	20646	3.13	227
$MSD_{.05}$	6385	25.8	19502	.67	41

Table 15. 1990 plant cane means of the 1988 "L" series at Westfield Plantation.

Variety	Sucrose yield	Cane yield	Stalk number	Stalk weight	Sucrose content
	lbs/A	tons/A	no./A	lbs	lbs/ton
CP65-357	4706	20.6	17243	2.40	215
CP70-321	10116	39.8	31536	2.58	254
CP74-383	5485	23.4	16789	2.83	239
L88-028	12987	44.5	33578	2.65	293
L88-030	5499	20.3	21554	1.88	273
L88-046	9649	36.1	33578	2.17	267
L88-049	5600	22.0	14974	2.85	251
L88-063	10201	41.0	35846	2.28	250
L88-066	9085	34.7	27452	2.61	261
L88-069	9182	37.6	26318	2.85	243
L88-070	8611	38.6	26318	2.92	225
L88-073	8225	30.6	36300	1.70	268
L88-075	8040	31.6	23822	2.48	253
LCP88-078	9852	38.3	27452	2.70	257
LCP88-079	7203	31.8	25864	2.48	227
LCP88-091	9432	36.0	23596	3.10	261
$MSD_{.05}$	7665	31.9	19296	.75	45

Table 16. 1990 plant cane means of the 1989 "L" series.

Variety	Sucrose yield	Cane yield	Stalk number	Stalk weight	Sucrose content	Fiber
	lbs/A	tons/A	no./A	lbs	lbs/ton	%
CP65-357	12030	40.9	28768	2.84	293	13.5
CP70-321	11893	41.5	29948	2.77	286	12.7
CP74-383	8987	30.9	22385	2.70	287	11.1
L89-095	14591	52.0	30553	3.41	280	13.6
L89-096	13152	44.1	37056	2.39	295	15.4
L89-097	10370	37.0	37586	1.96	279	11.8
L89-098	12237	45.4	31233	2.95	270	12.1
L89-099	14148	51.1	35166	2.92	280	11.9
L89-100	14065	48.4	31400	3.07	290	13.7
L89-101	11921	43.8	29343	2.95	271	13.4
L89-104	12355	48.8	37117	2.63	254	15.2
L89-105	12451	45.9	40293	2.28	270	12.0
LCP89-106	14080	52.2	33124	3.13	271	14.4
L89-107	15813	59.9	40989	2.91	264	12.5
L89-108	10851	39.5	31233	2.52	276	14.1
LCP89-109	12425	41.1	26771	3.10	302	12.7
L89-110	14315	52.8	31838	3.34	271	12.9
L89-111	11365	44.1	35393	2.51	256	13.0
L89-112	10018	37.5	35620	2.09	266	12.4
L89-113	14683	54.1	38871	2.75	270	14.5
L89-114	13049	53.5	43863	2.44	240	14.7
L89-115	12399	46.4	37283	2.47	263	12.6
L89-116	12235	46.2	35922	2.58	263	14.3
L89-118	14379	47.5	32746	2.89	299	13.5
L89-119	11087	44.0	30855	2.85	252	11.8
L89-120	13087	45.3	31006	2.97	281	13.8
L89-121	12524	44.1	27074	3.32	279	14.9
L89-122	13139	52.2	37571	2.77	255	14.2
L89-123	11584	45.3	32821	2.74	255	15.6
L89-124	15743	58.0	32973	3.49	270	10.5
L89-125	14115	49.6	27150	3.65	285	12.9
L89-126	13009	48.0	27754	3.45	274	13.7
LCP89-128	12267	47.5	35544	2.66	258	14.8
L89-134	10558	38.6	32579	2.38	272	12.2
L89-136	14631	51.1	30855	3.31	286	12.3
L89-137	11449	41.3	39930	2.06	277	14.1
L89-140	11632	42.5	32307	2.63	276	11.9
L89-141	12150	49.1	38932	2.56	248	11.7
L89-143	10449	40.8	23686	3.49	257	14.0
L89-144	11047	46.5	29131	3.18	236	12.0
L89-145	12490	45.6	37737	2.40	273	13.4
L89-147	13250	51.6	32368	3.18	257	11.6
L89-148	10971	37.9	26045	2.90	289	12.4
L89-149	11330	41.2	30326	2.72	272	13.1
L89-152	11183	41.1	37548	2.19	273	13.7
L89-155	11760	45.6	35015	2.61	253	11.6
L89-158	10596	38.8	28405	2.73	274	12.3
L89-160	10978	41.0	29343	2.78	268	11.8
L89-163	14750	49.9	35121	2.84	297	13.9
$MSD_{.05}$	6946	19.7	7492	.49	29	1.1

Table 17. 1990 plant cane means of the 1989 "L" series at the Iberia Research Station.

Variety	Sucrose yield	Cane yield	Stalk number	Stalk weight	Sucrose content	Fiber
	lbs/A	tons/A	no./A	lbs	lbs/ton	%
CP65-357	11352	40.3	30175	2.67	282	12.5
CP70-321	10703	38.3	28587	2.69	279	11.4
CP74-383	12386	42.2	30855	2.75	294	11.1
L89-095	17849	63.7	37208	3.43	280	13.4
L89-096	10580	38.1	34939	2.18	277	13.5
L89-097	11182	40.3	35166	2.30	276	10.7
L89-098	13612	47.8	29494	3.26	285	12.3
L89-099	15594	60.6	35620	3.40	259	11.2
L89-100	14860	53.2	36981	2.87	281	13.9
L89-101	16082	60.0	37435	3.21	268	12.9
L89-104	11753	45.3	37662	2.40	260	14.1
L89-105	13615	51.0	45375	2.24	264	10.8
LCP89-106	15983	63.0	36527	3.45	254	13.0
L89-107	15206	57.2	41292	2.76	263	11.7
L89-108	11670	41.8	34485	2.43	282	13.5
LCP89-109	10041	34.5	29267	2.36	291	11.8
L89-110	16010	60.2	36527	3.30	266	11.7
L89-111	8550	37.9	38569	1.96	228	12.1
L89-112	9554	36.8	35620	2.06	261	11.7
L89-113	11165	43.5	35846	2.42	257	13.7
L89-114	13209	56.2	49686	2.26	236	15.2
L89-115	11405	45.0	41519	2.16	256	11.5
L89-116	10953	41.7	36981	2.26	262	12.8
L89-118	17419	57.6	36981	3.13	303	12.7
L89-119	11616	49.1	33805	2.90	237	11.3
L89-120	13960	50.4	37889	2.65	271	12.7
L89-121	12051	44.3	32216	2.78	271	14.1
L89-122	12254	56.7	38342	2.94	222	13.2
L89-123	14878	56.2	36527	3.08	265	13.6
L89-124	20865	75.8	39023	3.89	275	10.1
L89-125	13043	46.8	26999	3.47	279	11.6
L89-126	14308	58.4	30401	3.82	244	13.1
LCP89-128	15222	54.9	37889	2.89	279	13.7
L89-134	8396	34.7	35166	1.97	242	11.1
L89-136	15856	54.7	35847	3.05	291	11.8
L89-137	12193	46.5	40838	2.29	262	12.9
L89-140	11080	46.5	33805	2.74	238	10.9
L89-141	12722	50.1	45375	2.20	257	11.3
L89-143	11175	47.1	29494	3.18	235	12.5
L89-144	11742	50.9	31536	3.24	231	11.9
L89-145	12537	47.3	41972	2.25	265	12.4
L89-147	13125	53.4	33578	3.18	245	11.4
L89-148	11793	42.5	29721	2.88	277	11.5
L89-149	14064	49.7	37435	2.66	284	12.5
L89-152	10728	43.0	39477	2.18	249	12.2
L89-155	9547	40.2	37661	2.14	238	11.1
L89-158	10853	42.0	30856	2.73	258	11.3
L89-160	13356	51.8	35847	2.90	258	10.9
L89-163	14348	51.5	36074	2.84	280	12.6
$MSD_{.05}$	5365	16.5	7912	.52	86	1.5

Table 18. 1990 plant cane means of the 1989 "L" series at the St. Gabriel Research Station on a Sharkey clay.

Variety	Sucrose yield	Cane yield	Stalk number	Stalk weight	Sucrose content	Fiber
	lbs/A	tons/A	no./A	lbs	lbs/ton	%
CP65-357	9308	31.5	22234	2.83	296	12.8
CP70-321	11104	39.7	28586	2.77	282	13.1
CP74-383	3757	13.7	11571	2.36	275	11.1
L89-095	11600	44.1	25637	3.44	263	13.3
L89-096	11454	39.1	37208	2.14	293	15.3
L89-097	8028	31.1	36527	1.67	262	10.9
L89-098	10967	45.1	36754	2.45	244	12.7
L89-099	11931	42.1	34939	2.47	284	12.5
L89-100	7836	28.3	21326	2.65	277	12.3
L89-101	8247	31.6	21780	2.87	259	12.7
L89-104	8907	35.6	25410	2.80	250	14.5
L89-105	9733	42.3	39930	2.12	230	11.5
LCP89-106	9324	33.6	23141	2.90	278	15.6
L89-107	15245	61.7	39023	3.13	249	12.3
L89-108	10140	37.3	27452	2.65	275	13.8
LCP89-109	12929	42.8	25864	3.31	302	12.5
L89-110	11354	46.6	26318	3.55	244	13.2
L89-111	9914	37.2	30629	2.43	268	13.1
L89-112	7816	30.5	29948	2.04	257	11.8
L89-113	13885	49.8	37889	2.63	279	14.2
L89-114	8248	37.3	30629	2.44	219	14.2
L89-115	7860	32.1	29494	2.19	245	11.6
L89-116	11143	48.0	35847	2.69	233	13.8
L89-118	9947	37.1	26545	2.78	266	12.9
L89-119	6700	25.9	18150	2.85	259	11.1
L89-120	7339	26.7	17243	3.18	266	14.3
L89-121	6857	25.9	15655	3.46	265	13.8
L89-122	9795	37.3	27225	2.74	263	14.0
L89-123	11221	46.0	31763	2.92	244	15.3
L89-124	13047	48.8	32897	2.92	265	10.6
L89-125	12879	43.9	24503	3.61	293	12.9
L89-126	13706	44.4	27906	3.18	309	13.7
LCP89-128	8737	35.1	26998	2.57	251	13.8
L89-134	9241	31.4	28586	2.20	294	11.9
L89-136	7100	25.8	15428	3.34	275	11.7
L89-137	10465	36.3	39931	1.78	282	14.0
L89-140	11644	40.9	30401	2.69	285	11.3
L89-141	14528	61.3	41291	2.97	237	11.8
L89-143	9014	32.0	18150	3.53	282	13.9
L89-144	10274	45.1	27225	3.31	228	11.5
L89-145	9424	34.8	30855	2.24	269	13.3
L89-147	12515	48.9	29948	3.23	258	11.2
L89-148	8398	29.6	21780	2.72	284	12.7
L89-149	9269	36.0	28360	2.48	250	12.5
L89-152	11589	40.1	36300	2.21	289	14.2
L89-155	11196	45.1	31536	2.83	242	10.3
L89-158	8332	28.8	22688	2.54	289	10.9
L89-160	7983	29.0	22688	2.58	273	11.2
L89-163	16527	55.2	34939	3.16	299	14.9
$MSD_{.05}$	12758	39.8	16562	.81	72	1.4

Table 19. 1990 plant cane means of the 1989 "L" series at the St. Gabriel Research Station on a Commerce silt loam.

Variety	Sucrose yield	Cane yield	Stalk number	Stalk weight	Sucrose content	Fiber
	lbs/A	tons/A	no./A	lbs	lbs/ton	%
CP65-357	14070	46.3	30629	3.02	303	14.9
CP70-321	13871	46.6	32670	2.85	298	13.5
CP74-383	10818	37.0	24730	2.99	294	11.3
L89-095	14324	48.3	28813	3.36	296	14.1
L89-096	17423	55.2	39023	2.85	316	17.3
L89-097	11902	39.7	41065	1.93	301	13.8
L89-098	12131	43.3	27452	3.15	280	11.4
L89-099	14921	50.5	34939	2.89	296	12.1
L89-100	16384	53.8	30856	3.49	307	14.1
L89-101	11433	40.0	28814	2.77	287	14.6
L89-104	14682	58.9	42426	2.78	250	16.6
L89-105	12647	42.6	35393	2.41	297	13.5
LCP89-106	14555	50.7	34712	2.92	286	15.3
L89-107	16989	60.8	42653	2.85	280	13.5
L89-108	10742	39.6	31763	2.49	270	14.9
LCP89-109	14305	46.0	25183	3.62	311	13.8
L89-110	15581	51.7	32670	3.19	302	13.9
L89-111	15633	57.4	36981	3.14	272	14.0
L89-112	12685	45.1	41292	2.18	281	13.8
L89-113	18999	69.0	42880	3.22	276	15.5
L89-114	17690	67.2	51274	2.62	264	14.5
L89-115	17931	62.0	40838	3.06	289	14.8
L89-116	14611	48.9	34939	2.79	296	16.4
L89-118	15770	48.0	34712	2.77	328	14.9
L89-119	12752	48.1	34258	2.81	265	12.7
L89-120	17963	58.7	37888	3.10	306	14.7
L89-121	18665	62.2	33351	3.73	300	16.7
L89-122	15696	55.3	41972	2.63	284	15.4
L89-123	8652	33.6	30175	2.23	257	17.9
L89-124	13318	49.3	26998	3.67	270	11.1
L89-125	16425	58.2	29948	3.88	282	14.2
L89-126	11013	41.3	24957	3.35	267	14.4
LCP89-128	12844	52.7	41746	2.52	243	17.0
L89-134	13379	46.2	31990	2.89	290	13.5
L89-136	17172	60.1	33578	3.57	286	13.0
L89-137	11689	41.1	39023	2.10	286	15.5
L89-140	12177	39.4	31763	2.48	310	13.3
L89-141	10389	42.0	31309	2.71	245	12.0
L89-143	10441	38.9	20646	3.78	268	15.6
L89-144	10739	42.9	27679	3.07	246	12.9
L89-145	15509	54.7	40384	2.71	285	14.5
L89-147	14111	52.5	33578	3.13	268	12.2
L89-148	11436	37.4	24503	3.02	303	13.2
L89-149	10658	37.9	25183	3.02	282	14.3
L89-152	11685	38.4	34939	2.20	304	16.0
L89-155	14536	51.5	35847	2.86	280	12.7
L89-158	11470	40.7	28814	2.83	282	14.1
L89-160	11596	42.4	29494	2.88	274	13.4
L89-163	14264	45.8	34259	2.68	312	14.9
$MSD_{.05}$	4671	13.3	7803	.45	33	2.6

1990 LOUISIANA (L) INFIELD VARIETY TRIALS

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The Louisiana sugarcane industry experienced one of its most severe freezes of the twentieth century during the period of December 22-26, 1989. Temperatures plummeted to below 9°F and continuously remained below freezing for some 96 hours, accompanied by strong northerly winds. Sugarcane fields in the northern parishes of the industry froze to depths ranging from three to five inches. Seriously compounding the disastrous effects of the severe freeze was the excessive amounts of rainfall during the first three months of the year 1990. The majority of the second and third ratoon crops in the industry were totally destroyed. Some of the plant cane and first ratoon crops survived, depending on soil types, varieties, and individual farm locations. Many farms in the southern parishes of the industry experienced very little damage due primarily to a good layer of snow that fell in those areas immediately preceding the freeze.

The effects of the severe freeze on the 1990 Louisiana (L) Sugarcane Variety Development Program at the St. Gabriel Research Station was beneficial in the sense that researchers could determine varieties possessing extreme cold tolerance during the dormant period after planting and harvesting. The freeze and subsequent wet weather, however, seriously affected all plots. It generally lowered yields and increased the variability of most tests.

The infield variety trials of the Louisiana (L) Sugarcane Variety Development Program are planted the year after number assignment through the year of introduction to outfield test locations for seed increase. During this period, all the trials are machine harvested for the first time. Their purpose is to initiate screening of experimental clones for mechanical harvestability and to obtain estimated yields on a larger plot basis than earlier stages of the selection program.

Infield variety trials were planted in Sharkey clay (very fine, mont-morillontic, nonacid, thermic, typic hydralquent) and Commerce silt loam (fine-silty, mixed, nonacid, thermic, aeric fluvaquent) soils at the St. Gabriel Research Station. Planting dates for the infield variety trials commenced on August 21 and terminated on September 25, 1990 (Table 1). A randomized complete block design with plots 16 feet by three rows on six foot centers replicated twice were used on all trials. Included in all trials were three commercial check varieties, CP74-383, CP70-321, and CP65-357. Unburned plots were mechanically cut and weighed with a tractor mounted hydraulic weigh rig from November 13 through November 21, 1990. Plot weights were used

to determine cane yield. No adjustment was made for leaf trash. Ten-stalk samples, stripped of leaves, were used to estimate stalk weight and obtain a juice analysis.

Normal cultural practices were used in 1990. Sinbar (1/2 lb./A terbacil) was applied immediately after planting in the fall. In late January, 2,4-D (1 qt./A; 46.88% AI) and Atrazine (2 qt./A) was applied to all plant cane and most ratoon trials. In late April, 2,4-D (1 qt./A; 46.88% AI) was applied to remaining ratoon trials. Sencor 4L (2 qt./A; 41% AI) was applied after off-barring in late April. Asulox (4.0 pts./A) was applied twice, once in late April and again in late May. Fields were fertilized (102 lbs. N and 60 lbs. K_2O per A) in the early part of May. Atrazine (2 qt./A) was used as a pre-emergence herbicide after lay-by in early June. Sugarcane borer (*Diatrea saccharalis*) populations were checked on a weekly basis. No pesticide applications were made due to extremely low infestation in 1990.

Crusher juice was analyzed for sucrose by polarization and Brix was measured by refractometer. Sugar content was calculated using Brix and sucrose values according to the methods described by Legendre and Henderson (1972). Sucrose yield was estimated as the product of cane yield and sucrose content.

Analysis of variance was performed for each crop and assignment series over and by soil type when appropriate. Minimum significant differences (MSD) were calculated by the Waller-Duncan multiple range test (SAS, 1985).

References

Legendre, B. L. and M. T. Henderson. 1972. The history and development of sugar yield calculations. Proc. Am. Soc. Sugar Cane Technol. 2(ns): 10-18.

SAS Institute Inc. SAS User's Guide: Statistics, Ver. 5 ed. Cary, NC: SAS Institute Inc., 1985 956pp.

Table 1. Planting and harvest dates of infield tests.

Assignment Series	Reps.	Soil[1] Texture	Planting Dates	Harvest Dates 1988	1989	1990
1984 L & CP	2	C.s.l.	9/04/87	11/22	11/03	11/13
1984 L & CP	2	S.c.	9/09/87	11/30	11/10	11/12
1985 L	2	C.s.l.	9/04/87	11/15	11/10	11/16
1985 L	2	S.c.	9/11/87	11/30	11/10	11/12
1986 L	2	C.s.l.	9/18/87	11/28	11/03	11/16
1986 L	2	S.c.	9/15/87	12/01	11/27	11/12
1985 & 1986 L & CP	1	C.s.l.	9/15/88		11/29	11/19
1985 & 1986 L & CP	1	S.c.	9/31/88		11/20	11/13
1987 L	1	C.s.l.	9/15/88		11/29	11/19
1987 L	1	S.c.	9/31/88		11/20	11/13
1986 L & CP	2	C.s.l.	9/21/89			11/20
1986 L & CP	2	S.c.	9/21/89			11/20
1987 L & CP	1	C.s.l.	9/19/89			11/20
1987 L & CP	1	S.c.	9/19/89			11/20
1988 L	2	C.s.l.	8/25/89			11/21
1988 L	2	S.c.	9/22/89			11/20
1987 L & CP	2	C.s.l.	8/21/90			
1987 L & CP	2	S.c.	8/30/90			
1988 L & CP	2	C.s.l.	8/22/90			
1988 L & CP	2	S.c.	9/26/90			
1989 L	2	C.s.l.	9/28/90			
1989 L	2	S.c.	9/25/90			

[1] C.s.l - Commerce silt loam; S.c. - Sharkey clay.

Table 2. 1990 second ratoon means of the 1984 CP series over soil types at St. Gabriel.

Variety	Sucrose yield	Cane yield	Sucrose content	Stalk weight	Stalk number
	(lbs/A)	(tons/A)	(lbs/ton)	(lbs)	(no/A)
CP65-357	6382	26.4	237	2.08	25075
CP70-321	5474	21.8	249	1.75	23996
CP74-383	7849	32.5	239	2.15	30500
CP84-730	8939	34.4	258	2.18	31297
$MSD_{0.05}$	1668	9.3	20	0.32	7893

Table 3. 1990 second ratoon means of the 1984 CP series on Sharkey clay soil at St. Gabriel.

Variety	Sucrose yield	Cane yield	Sucrose content	Stalk weight	Stalk number
	(lbs/A)	(tons/A)	(lbs/ton)	(lbs)	(no/A)
CP65-357	4734	21.5	218	1.98	21479
CP70-321	2975	12.3	242	1.54	16256
CP74-383	5875	25.9	226	2.07	26038
CP84-730	7341	30.1	244	2.16	27655
$MSD_{0.05}$	NS	NS	31	NS	NS

Table 4. 1990 second ratoon means of the 1984 CP series on Commerce silt loam soil at St. Gabriel.

Variety	Sucrose yield	Cane yield	Sucrose content	Stalk weight	Stalk number
	(lbs/A)	(tons/A)	(lbs/ton)	(lbs)	(no/A)
CP65-357	8031	31.3	257	2.19	28670
CP70-321	7974	31.3	257	1.97	31736
CP74-383	9823	39.0	252	2.23	34961
CP84-730	10538	38.7	272	2.20	34940
$MSD_{0.05}$	3003	10.0	NS	0.24	NS

Table 5. 1990 second ratoon means of the 1985 L & CP series over soil types at St. Gabriel.

Variety	Sucrose yield	Cane yield	Sucrose content	Stalk weight	Stalk number
	(lbs/A)	(tons/A)	(lbs/ton)	(lbs)	(no/A)
CP65-357	4698	21.4	224	2.17	19510
CP70-321	5821	27.4	216	1.95	26759
CP74-383	8803	36.4	242	2.06	35678
LCP85-336	7472	33.7	221	2.14	31420
LCP85-376	9123	37.0	246	1.80	41172
LCP85-384	10724	42.1	255	1.80	47161
CP85-845	9360	37.2	252	2.29	32466
$MSD_{0.05}$	3430	16.9	NS	NS	15121

Table 6. 1990 second ratoon means of the 1985 L & CP series on Commerce silt loam soil at St. Gabriel.

Variety	Sucrose yield	Cane yield	Sucrose content	Stalk weight	Stalk number
	(lbs/A)	(tons/A)	(lbs/ton)	(lbs)	(no/A)
CP65-357	5110	25.4	201	2.22	22857
CP70-321	7220	35.5	204	2.46	29109
CP74-383	8761	35.5	247	2.16	33252
LCP85-336	8196	36.8	223	2.26	32566
LCP85-376	9747	37.2	262	1.82	40911
LCP85-384	9769	39.4	248	1.93	40960
CP85-845	9360	37.2	252	2.29	32466
$MSD_{0.05}$	4494	5.3	NS	0.41	8208

Table 7. 1990 second ratoon means of the 1985 L series on Sharkey clay soil at St. Gabriel.

Variety	Sucrose yield	Cane yield	Sucrose content	Stalk weight	Stalk number
	(lbs/A)	(tons/A)	(lbs/ton)	(lbs)	(no/A)
CP65-357	4286	17.5	247	2.11	16163
CP70-321	4422	19.2	227	1.44	24408
CP74-383	8845	37.4	236	1.96	38104
LCP85-336	6748	30.7	220	2.03	30273
LCP85-376	8499	36.9	230	1.79	41433
LCP85-384	11680	44.8	262	1.68	53361
$MSD_{0.05}$	6648	27.9	29	NS	19955

Table 8. 1990 second ratoon means of the 1986 L series over soil types at St. Gabriel.

Variety	Sucrose yield	Cane yield	Sucrose content	Stalk weight	Stalk number
	(lbs/A)	(tons/A)	(lbs/ton)	(lbs)	(no/A)
CP65-357	4659	21.3	224	2.00	19795
CP70-321	5358	22.9	231	1.96	22504
CP74-383	6011	27.0	226	1.99	26393
LCP86-408	5430	23.2	234	1.69	24618
LCP86-420	5690	22.4	245	1.61	26876
LCP86-429	7409	33.7	223	2.15	30976
LCP86-454	4805	22.2	216	2.06	21252
$MSD_{0.05}$	NS	13.0	NS	0.52	NS

Table 9. 1990 second ratoon means of the 1986 L series on Sharkey clay soil at St. Gabriel.

Variety	Sucrose yield	Cane yield	Sucrose content	Stalk weight	Stalk number
	(lbs/A)	(tons/A)	(lbs/ton)	(lbs)	(no/A)
CP65-357	1999	8.8	230	1.64	10854
CP70-321	2927	12.8	226	1.42	18542
CP74-383	3607	15.8	231	1.85	17132
LCP86-408	1672	7.3	230	1.33	10938
LCP86-420	2677	12.0	225	1.43	16783
LCP86-429	6013	25.7	234	1.92	26823
LCP86-454	3523	16.7	212	1.80	18538
$MSD_{0.05}$	1971	9.3	NS	0.27	14194

Table 10. 1990 second ratoon means of the 1986 L series on Commerce silt loam soil at St. Gabriel.

Variety	Sucrose yield	Cane yield	Sucrose content	Stalk weight	Stalk number
	(lbs/A)	(tons/A)	(lbs/ton)	(lbs)	(no/A)
CP65-357	7320	33.8	217	2.35	28735
CP70-321	7789	33.0	236	2.49	26467
CP74-383	8415	38.2	221	2.14	35654
LCP86-408	9189	39.1	237	2.04	38299
LCP86-420	8703	32.8	266	1.79	36970
LCP86-429	8806	41.7	212	2.38	35128
LCP86-454	6087	27.7	221	2.31	23966
$MSD_{0.05}$	1151	8.4	59	0.31	9423

Table 11. 1990 first ratoon means of the 1985 and 1986 L and CP series over soil types at St. Gabriel.

Variety	Sucrose yield	Cane yield	Sucrose content	Stalk weight	Stalk number
	(lbs/A)	(tons/A)	(lbs/ton)	(lbs)	(no/A)
CP65-357	5735	24.6	232	2.26	21783
CP70-321	4394	25.1	194	2.05	22976
CP74-383	9886	40.8	241	2.48	32882
LCP85-336	8065	30.2	265	2.32	26002
LCP85-376	9258	38.9	237	2.27	34564
LCP85-384	10842	42.0	259	2.00	41570
CP85-845	9486	40.7	233	2.55	31964
LCP86-408	7701	34.7	223	2.08	33794
LCP86-420	5675	23.2	245	2.09	22339
LCP86-429	8843	34.6	254	2.10	33216
LCP86-454	6839	33.4	208	2.47	26853
CP86-979	6695	29.0	231	2.21	26413
$MSD_{0.05}$	2563	16.8	84	0.68	13566

Table 12. 1990 first ratoon means of the 1987 L series over soil types at St. Gabriel.

Variety	Sucrose yield	Cane yield	Sucrose content	Stalk weight	Stalk number
	(lbs/A)	(tons/A)	(lbs/ton)	(lbs)	(no/A)
CP65-357	6031	24.7	243	2.29	21824
CP70-321	7938	31.7	244	2.07	29984
CP74-383	8179	33.8	242	2.21	31655
LCP87-017	7439	30.2	248	1.97	31611
LCP87-023	6879	29.2	236	2.07	27977
LCP87-472	6710	32.2	209	2.11	32563
LCP87-479	7388	40.4	181	2.24	37199
LCP87-491	8879	35.7	250	1.77	40401
LCP87-492	9893	41.9	235	2.01	41753
LCP87-494	7721	35.3	219	2.29	30918
LCP87-496	8160	41.4	201	2.17	37605
$MSD_{0.05}$	NS	NS	31	NS	NS

Table 13. 1990 plant cane means of the 1986 L and CP series over soil types at St. Gabriel.

Variety	Sucrose yield	Cane yield	Sucrose content	Stalk weight	Stalk number
	(lbs/A)	(tons/A)	(lbs/ton)	(lbs)	(no/A)
CP65-357	8282	33.1	251	2.92	21532
CP70-321	8263	32.4	259	2.81	22729
CP74-383	9784	41.3	237	2.84	29154
LCP86-408	9284	39.4	238	2.62	29711
LCP86-420	8656	32.2	265	2.37	26908
LCP86-454	14141	52.4	269	3.23	32485
CP86-979	7743	31.6	243	2.30	27048
$MSD_{0.05}$	2404	13.4	NS	0.78	4534

Table 14. 1990 plant cane means of the 1986 L and CP series on Sharkey clay soil at St. Gabriel.

Variety	Sucrose yield	Cane yield	Sucrose content	Stalk weight	Stalk number
	(lbs/A)	(tons/A)	(lbs/ton)	(lbs)	(no/A)
CP65-357	5241	21.1	251	2.45	16494
CP70-321	6963	25.0	277	2.54	19673
CP74-383	8641	38.3	227	2.85	26950
LCP86-408	7701	31.1	250	2.42	25537
LCP86-420	6449	25.9	247	2.29	22518
LCP86-454	12466	50.8	246	3.27	31073
CP86-979	5293	22.2	238	1.89	23804
$MSD_{0.05}$	4616	15.7	NS	0.82	10883

Table 15. 1990 plant cane means of the 1986 L and CP series on Commerce silt loam soil at St. Gabriel.

Variety	Sucrose yield	Cane yield	Sucrose content	Stalk weight	Stalk number
	(lbs/A)	(tons/A)	(lbs/ton)	(lbs)	(no/A)
CP65-357	11323	45.0	251	3.39	26570
CP70-321	9563	39.9	240	3.09	25785
CP74-383	10928	44.3	247	2.83	31357
LCP86-408	10867	47.7	225	2.81	33886
LCP86-420	10864	38.4	283	2.46	31299
LCP86-454	15817	54.0	293	3.19	33897
CP86-979	10193	41.0	249	2.72	30293
$MSD_{0.05}$	6726	4.8	NS	0.31	3008

Table 16. 1990 plant cane means of the 1987 L and CP series over soil types at St. Gabriel.

Variety	Sucrose yield	Cane yield	Sucrose content	Stalk weight	Stalk number
	(lbs/A)	(tons/A)	(lbs/ton)	(lbs)	(no/A)
CP65-357	5163	27.8	205	2.68	20856
CP70-321	12676	44.0	288	3.16	27985
CP74-383	6813	33.8	207	2.95	22878
LCP87-017	11735	44.7	263	2.83	31586
LCP87-023	11508	43.0	267	2.94	29283
LCP87-472	12069	52.3	229	2.63	39618
LCP87-479	14441	54.4	263	2.60	41803
LCP87-491	8943	36.8	242	2.18	32971
LCP87-492	7691	44.9	181	2.16	41383
LCP87-494	10683	42.7	249	3.27	26107
LCP87-496	8031	29.8	266	2.45	23496
CP87-609	8753	37.9	234	2.49	30467
CP87-618	10785	41.0	262	2.29	35709
CP87-625	8914	41.9	215	2.71	30821
CP87-626	10589	40.2	263	2.79	28936
CP87-644	6396	27.4	232	3.00	18204
CP87-649	9400	33.7	279	3.37	20106
CP87-652	9834	37.3	262	2.57	28995
CP87-653	7773	31.0	251	2.51	25049
CP87-657	10571	38.5	269	2.88	26499
CP87-658	13093	47.8	274	2.54	37638
CP87-662	8273	29.9	277	2.53	23568
CP87-663	8065	46.1	179	2.52	37830
$MSD_{0.05}$	5976	18.5	106	0.55	15018

Table 17. 1990 plant cane means of the 1988 L series over soil types at St. Gabriel.

Variety	Sucrose yield	Cane yield	Sucrose content	Stalk weight	Stalk number
	(lbs/A)	(tons/A)	(lbs/ton)	(lbs)	(no/A)
CP65-357	8017	31.8	253	2.84	22280
CP70-321	10693	40.5	264	2.81	28606
CP74-383	9801	39.7	249	3.06	25696
L88-028	9085	31.8	285	2.41	26289
L88-030	10378	40.6	256	2.22	36775
L88-046	10441	40.8	258	2.38	34097
L88-049	9457	39.2	243	3.08	25269
L88-063	10500	42.5	248	2.51	33978
L88-066	10513	39.8	265	2.45	32712
L88-069	8929	36.9	242	2.68	27244
L88-070	9450	43.9	220	2.92	29593
L88-073	10274	42.5	240	2.47	35010
L88-075	9705	37.7	259	2.36	31552
LCP88-078	9910	38.1	261	2.72	27946
LCP88-079	9433	35.4	269	3.02	23084
LCP88-091	9311	36.5	256	2.91	24971
$MSD_{0.05}$	NS	13.8	25	0.35	7637

Table 18. 1990 plant cane means of the 1988 L series on Sharkey clay soil at St. Gabriel.

Variety	Sucrose yield	Cane yield	Sucrose content	Stalk weight	Stalk number
	(lbs/A)	(tons/A)	(lbs/ton)	(lbs)	(no/A)
CP65-357	7092	27.1	261	2.62	20690
CP70-321	8588	32.6	264	2.66	24507
CP74-383	8292	32.3	258	2.86	22545
L88-028	7135	25.4	282	2.31	22130
L88-030	10505	37.9	276	2.21	34044
L88-046	8356	31.7	264	2.30	27620
L88-049	7774	31.4	249	2.74	22942
L88-063	10281	40.0	257	2.51	31922
L88-066	9521	34.7	275	2.49	27964
L88-069	6455	26.9	240	2.57	20672
L88-070	8024	33.5	239	2.64	25245
L88-073	6707	29.1	232	2.44	25061
L88-075	7735	29.2	266	2.09	28077
LCP88-078	8646	33.0	262	2.52	26316
LCP88-079	7185	25.9	278	2.76	18732
LCP88-091	8874	33.7	264	2.80	23937
$MSD_{0.05}$	3605	14.8	30	0.63	10239

Table 19. 1990 plant cane means of the 1988 L series on Commerce silt loam soil at St. Gabriel.

Variety	Sucrose yield	Cane yield	Sucrose content	Stalk weight	Stalk number
	(lbs/A)	(tons/A)	(lbs/ton)	(lbs)	(no/A)
CP65-357	8943	36.5	246	3.05	23870
CP70-321	12798	48.5	264	2.97	32706
CP74-383	11309	47.1	241	3.27	28847
L88-028	11036	38.3	288	2.52	30449
L88-030	10251	43.4	237	2.23	39506
L88-046	12526	49.8	252	2.46	40575
L88-049	11140	47.1	237	3.42	27597
L88-063	10719	45.0	238	2.51	36034
L88-066	11505	44.9	256	2.41	37460
L88-069	11403	46.9	244	2.80	33817
L88-070	10876	54.4	200	3.21	33941
L88-073	13842	55.9	248	2.49	44958
L88-075	11675	46.1	253	2.63	35027
LCP88-078	11175	43.1	260	2.92	29576
LCP88-079	11682	44.9	261	3.28	27436
LCP88-091	9749	39.3	249	3.02	26005
$MSD_{0.05}$	1451	6.4	17	0.44	7393

1990 L.S.U. Outfield Variety Trials

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The twelve year selection cycle of the Louisiana Sugarcane Variety Development Program culminates in the outfield variety trials. The purpose of these trials is to test the most promising experimental varieties across the range of environmental conditions, farm management scenarios and mechanical harvesting situations a successful variety must endure. To accomplish this goal, LSU, the USDA and the American Sugarcane League cooperatively conduct trials at thirteen commercial farms throughout the sugarcane belt. LSU is primarily responsible for seven of these tests (Table 1), while the USDA is primarily responsible for the other six. Reported here are the results from the LSU sites in 1990.

Six commercial and ten experimental varieties were planted in outfield variety trials in 1990 (Table 2). Normally, three trials (plant cane, first and second ratoon) are harvested from each location. In each of these trials, experimental varieties are evaluated along with recommended varieties under commercial farm conditions. The location of these tests represent the soil types, managerial structures, and weather patterns of the major sugarcane producing areas of the state. Due to the severe freeze of December 1989 and the excessive rainfall of early 1990, many tests were lost and in some cases only seed plots were reestablished at the sites.

Pathologists and entomologists, from both LSU and USDA, frequently evaluated disease and insect pressures at the outfield locations. These data were recorded and used by the scientists in their respective disciplines to appraise the resistance and/or susceptibility of experimental varieties to specific crop pests.

Three replications of each variety were planted in three row plots 32 feet long. Rows were on six foot centers. A randomized complete block design was used at each location. Twenty-one experimental varieties were also introduced to the outfield locations for seed increase in 1990.

The number of millable stalks in all plots were counted in August and September. All trials were harvested mechanically, separated by hand and then weighed with a tractor-mounted hydraulic weigh rig. A fifteen stalk sample was taken from each plot and sent to the USDA sucrose lab at the Ardoyne Farm for juice analysis.

Results from the 1990 harvest can be found in Tables 3 through 8. For tests in which stalk counts were made, an analysis was performed for yields based on stalk counts (CNTS) and yields based on plot weights (PWT).

Table 1. Locations and dates of planting for the LSU outfield variety trials planted in 1990.

Locations	Planting Date	Soil Type	Soil Texture
A.V. Allain	09/05/90	Baldwin silty clay	silty clay
Evan Hall	08/27/90	Sharkey clay	silty clay
Frank Pearce	10/09/90	Commerce silt loam	silty loam
Lanaux	10/25/90	Commerce silt loam	silty loam
Cinclare	10/11/90	Convent silt loam	v.f.s.loam
Glenwood	10/12/90	Commerce silt loam	silty loam
Levert-St. John	10/03/90	Dundee silt loam	silty loam

Table 2. Varieties planted in the outfield variety trials in 1990.

Commercial Varieties	Experimental Varieties		Varieties introduced to outfield	
CP65-357	LCP83-153	LCP86-408	LCP86-429	CP87-609
CP70-321	CP84-730	LCP86-420	LCP87-017	CP87-618
CP72-370	LCP85-336	LCP86-454	LCP87-023	CP87-625
CP74-383	LCP85-376	CP86-979	LCP87-472	CP87-626
CP79-318	LCP85-384		LCP87-479	CP87-644
LCP82-089	CP85-845		LCP87-491	CP87-649
			LCP87-492	CP87-652
			LCP87-494	CP87-653
			LCP87-496	CP87-657
				CP87-658
				CP87-662
				CP87-663

A. V. Allain & Sons: Only the plant cane and first ratoon tests were harvested at this location. Both tests were cut with a two-row harvester in two directions. All varieties were erect and harvested well. Weed pressure was light and limited to johnsongrass and bermudagrass in the alleys.

Table 3. The 1990 results from the plant cane variety trial at Allain.

Variety	Sucrose yield	Sucrose content	Cane yield	Stalk weight	Population pwt.	Population cnts.	Erectness	Scrap
	(lbs/A)	(lbs/T)	(T/A)	(lbs)	(Number/A)			
CP65-357	6496	271	24.0	2.73	17723	17073	Erect	None
CP70-321	7046	266	26.5	2.74	19369	19328	Erect	None
CP72-370	6960	268	26.0	2.68	19341	18133	Erect	None
CP74-383	7116	257	27.7	2.26	24788	21987	Erect	None
CP79-318	7048	247	28.5	2.79	20536	21718	Erect	None
LCP82-089	7011	255	27.4	2.66	20608	20311	Erect	None
CP82-551	6693	263	25.4	2.24	22685	18172	Erect	None
LCP83-153	7789	267	29.2	2.23	26207	23259	Erect	None
CP84-730	8497	289	29.4	3.02	19591	16997	Erect	None
LCP85-336	6444	274	23.5	2.55	18455	19078	Erect	None
LCP85-376	6587	254	25.9	2.68	19374	19848	Erect	None
LCP85-384	9739	266	36.6	2.46	30031	30890	Erect	None
CP85-845	7657	255	30.0	2.45	24498	21467	Erect	None
$MSD_{.05}$	800	17	2.6	.30	3255	2845		

Date Planted: 09/28/89 Soil Type: Baldwin silty clay
Date Harvested: 11/19/90 Harvest Condition: Good

Table 4. 1990 results from the first ratoon variety trial at Allain.

Variety	Sucrose yield	Sucrose content	Cane yield	Stalk weight	Population pwt.	Population cnts.	Erectness	Scrap
	(lbs/A)	(lbs/T)	(T/A)	(lbs)	(Number/A)			
CP70-321	7469	287	26.1	2.11	24898	23221	Erect	None
CP72-370	7585	276	27.5	2.05	26930	23298	Erect	None
CP74-383	8240	268	30.8	1.80	34108	28366	Erect	None
CP79-318	7549	274	27.5	2.24	24614	23934	Erect	None
LCP82-089	7903	283	28.0	2.23	25148	23163	Erect	None
CP82-551	7157	274	26.1	2.06	25316	23183	Erect	None
LCP83-153	8279	276	30.0	2.25	26837	26362	Erect	None
CP84-730	7305	296	24.7	2.45	20270	17536	Erect	None
$MSD_{.05}$	873	15	3.1	.27	4352	2162		

Date Planted: 10/14/88 Soil Type: Baldwin silty clay
Date Harvested: 11/19/90 Harvest Condition: Good

Evan Hall: Only the plant cane test was harvested at this location. It was cut with a two-row harvester in two directions. Several varieties were open or lodged, but were not scrappy. There was heavy johnsongrass stands in the alleys only.

Table 5. 1990 results from the plant cane variety trial at Evan Hall.

Variety	Sucrose yield	Sucrose content	Cane yield	Stalk weight	Population pwt.	Population cnts.	Erectness	Scrap
	(lbs/A)	(lbs/T)	(T/A)	(lbs)	(Number/A)			
CP65-357	6526	231	28.2	2.34	24253	20600	Erect	None
CP70-321	7878	299	26.3	2.58	20451	22065	Erect	None
CP72-370	7244	267	27.2	2.60	20906	19579	Erect	None
CP74-383	6748	244	27.7	2.20	25173	23780	Erect	None
CP79-318	7497	285	26.3	2.68	19646	19136	Erect	None
LCP82-089	5689	272	20.9	2.34	17845	16920	Erect	None
CP82-551	6079	239	25.2	1.96	25736	19482	Erect	None
LCP83-153	6691	248	26.9	2.12	25257	23471	Open	None
CP84-730	7147	283	25.3	2.88	17571	16515	Lodged	Some
LCP85-336	6512	272	24.0	2.07	23406	19945	Open	None
LCP85-376	5291	232	23.1	2.36	19586	17767	Open	None
LCP85-384	7397	261	28.4	1.91	30067	25707	Erect	None
CP85-845	6687	242	27.9	2.36	24038	21005	Erect	None
$MSD_{.05}$	1983	20	8.9	.30	7176	7537		

Date Planted: 10/10/89 Soil Type: Sharkey clay
Date Harvested: 11/01/90 Harvest Condition: Good

Lanaux: The second ratoon test was the only one harvested at this location. The test was cut with a two-row harvester in two directions. All varieties were erect and harvested well. There was moderate johnsongrass and tie vine pressure throughout the test.

Table 6. 1990 results from the second ratoon variety trial at Lanaux.

Variety	Sucrose yield	Sucrose content	Cane yield	Stalk weight	Population pwt.	Population cnts.	Erectness	Scrap
	(lbs/A)	(lbs/T)	(T/A)	(lbs)	(Number/A)			
CP65-357	4792	222	21.6	2.35	18546	12449	Erect	None
CP70-321	3636	212	17.2	2.18	15787	10348	Erect	None
CP74-383	5867	219	26.8	2.26	23992	18538	Erect	None
CP76-331	4708	223	21.1	2.55	16616	11909	Erect	None
CP79-318	4662	225	20.7	2.32	17987	14723	Erect	None
LCP82-089	3668	204	17.7	2.23	15624	8942	Erect	None
CP82-551	6541	224	29.2	2.11	27747	20503	Erect	None
LCP83-153	5442	225	24.1	2.08	23206	18770	Erect	None
$MSD_{.05}$	1388	NS	5.6	.49	5452	3778		

Date Planted: 09/15/87 Soil Type: Commerce silt loam
Date Harvested: 11/07/90 Harvest Condition: Good

Frank Pearce & Sons: The second ratoon test at this location was not harvested. The plant cane and first ratoon tests were cut with a two-row harvester in two directions. Both tests were erect and harvested well. There was heavy itchgrass pressure in the alleys only.

Table 7. 1990 results from the plant cane variety trial at Pearce.

Variety	Sucrose yield	Sucrose content	Cane yield	Stalk weight	Population pwt.	Population cnts.	Erectness	Scrap
	(lbs/A)	(lbs/T)	(T/A)	(lbs)	(Number/A)			
CP65-357	6280	249	25.2	2.87	17520	15879	Erect	None
CP70-321	7819	272	28.9	2.68	21612	18962	Erect	None
CP74-383	6922	240	29.0	2.33	25211	21833	Erect	None
CP79-318	7342	261	28.1	2.71	20796	19097	Erect	None
LCP82-089	5580	234	23.8	2.66	17995	13990	Erect	None
CP82-551	6424	265	24.2	2.13	22789	17787	Erect	None
LCP83-153	4881	225	21.8	2.17	19908	14260	Erect	None
CP84-730	8270	299	27.8	3.25	17113	15108	Erect	None
LCP85-336	5729	245	23.2	2.48	18733	14202	Erect	None
LCP85-376	5908	251	23.6	2.66	17713	15243	Erect	None
LCP85-384	6600	267	24.9	2.30	21571	19694	Erect	None
CP85-845	7485	262	28.6	2.44	23467	18654	Erect	None
$MSD_{.05}$	2285	17	NS	.30	8463	7934		

Date Planted: 09/25/89 Soil Type: Commerce silt loam
Date Harvested: 11/15/90 Harvest Condition: Good

Table 8. 1990 results from the first ratoon variety trial at Pearce.

Variety	Sucrose yield	Sucrose content	Cane yield	Stalk weight	Population pwt.	Population cnts.	Erectness	Scrap
	(lbs/A)	(lbs/T)	(T/A)	(lbs)	(Number/A)			
CP65-357	5403	250	21.5	2.36	18293	10676	Erect	None
CP70-321	6466	278	23.1	2.50	18478	15147	Erect	None
CP74-383	6484	233	27.5	2.02	26889	16630	Erect	None
CP76-331	5290	252	21.1	2.28	18574	10464	Erect	None
CP79-318	6035	243	24.8	2.34	21377	16765	Erect	None
CP82-551	6108	255	24.0	1.93	24833	15416	Erect	None
LCP83-153	6841	232	29.5	2.02	29115	19848	Erect	None
CP84-730	6438	285	22.5	2.36	19053	11890	Erect	None
$MSD_{.05}$	NS	19	NS	.26	12520	7800		

Date Planted: 10/19/88 Soil Type: Commerce silt loam
Date Harvested: 11/15/90 Harvest Condition: Good

Acknowledgements:

The data for this report were obtained through a cooperative effort of personnel from the Louisiana Agricultural Experiment Station - LSUAC; USDA - Agricultural Research Service, Sugarcane Research Unit; and the American Sugarcane League in accordance to the provisions of the "Three-way Agreement of 1978". The testing program would not be possible without full cooperation from the growers at each outfield location.

SUMMARY OF THE 1990 OUTFIELD VARIETY TRIALS FOR YIELD AND HARVESTABILITY ACROSS LOCATIONS

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The purpose of the outfield variety trials is to test and identify experimental varieties for potential commercial production. These trials are cooperatively conducted at 13 locations throughout the Louisiana sugarcane belt by the Louisiana Agricultural Experiment Station, the United States Department of Agriculture - Agricultural Research Service and the American Sugarcane League.

The criteria for a successful variety includes reasonable performance with regard to yield and harvestability across locations, crops, and years relative to commercial varietal responses. Accurate varietal evaluation requires overall performance information in addition to close scrutiny of performance under adverse harvest conditions. The objective of this report is to provide an overall and specific location - crop yield and harvest data compilation for 1990 outfield locations. Details of the type of data collected and analyis performed are described in the "1990 LSU Outfield Variety Trials" summary found in this annual report.

Two estimates of cane yield were made for each plot. One was based upon stalk counts (stalk count * stalk weight), the other was estimated by the plot weight. The effect of locations and crops (grouped by soil texture) on varietal yield can be found in tables 2 through 19.

The harvestability of a sugarcane variety in Louisiana is affected by the erectness and the brittleness of the variety in interaction with the conditions under which it was grown and harvested (weather, row profile, type and condition of the harvester, and skill of the harvester operator). The harvestability of experimental varieties can be observed under a wide range of conditions in the outfield stage of the variety testing program and is an important function of the tests.

As part of the overall process, the condition of the test field is documented at the time of the harvest. As the test field is cut, the outfield agronomists note the erectness (or lack of) of each variety for which yield data will be taken. After the test field is cut, the heap row for each variety is subjectively rated for scrappiness or the amount of cane left in the plot. Although most varieties behave consistently at a specific location, a variety was considered to be scrappy or lodged for a test if it was rated as scrappy or lodged in any one replication. The data in tables 20 through 23 represent the number of locations in which each variety was rated in each category with regards to pre-harvest erectness and post-harvest scrap. Although most tests

harvested well in 1990, it can be seen that some varieties do not harvest well under certain conditions.

Acknowledgements

The data for this report were obtained through a cooperative effort of personnel from the Louisiana Agricultural Experiment Station-LSUAC; USDA-Agricultural Research Service, Sugarcane Research Unit; and the American Sugarcane League in accordance to the provisions of the "Three-way Agreement of 1978". The testing program would not be possible without the full cooperation from the growers at each outfield location.

Table 1. Plant cane, first ratoon, and second ratoon harvest and planting & dates for all outfield locations harvested in 1990.

	Plant cane		1st ratoon		2nd ratoon	
Location	Harvest '90	Plant '89	Harvest '90	Plant '88	Harvest '90	Plant '87
Allains	11/19	09/28	11/19	10/14	-----	-----
Evan Hall	11/01	10/10	-----	-----	-----	-----
F. Pearce	11/15	09/25	11/15	10/19	-----	-----
Magnolia	12/12	09/19	11/08	10/11	-----	-----
McLeod	11/06	09/20	-----	-----	-----	-----
Oaklawn H.	11/20	09/27	-----	-----	10/31	09/23
Bon Secour	12/04	08/31	11/08	09/23	-----	-----
Georgia	12/13	09/14	12/13	10/10	10/26	09/25
R. Hebert	11/14	09/25	11/14	10/06	-----	-----
Oaklawn L.	-----	-----	10/31	10/13	-----	-----
Laneaux	-----	-----	-----	-----	11/07	09/15

Table 2. Plant cane sucrose yield for six commercial and seven experimental varieties at nine outfield locations in 1990.

	Heavy textured soil locations					Light textured soil locations				NS	
Variety	All.[1]	E.H.	Mag.	McL.	O.H.	B.S.	F.P.	Geo.	R.H.	MEAN	from Best[2]
	lbs/A										%
CP65-357	6496	6526	8056	9216	8421	7583	6280	7552	5313	7271	55.6
CP70-321	7046	7878	8591	7988	7777	7368	7819	7378	6617	7607	55.6
CP72-370	6960	7244	7697	7767	7069	----	----	----	----	7348	40.0
CP74-383	7116	6748	6509	8777	7330	7136	6922	7316	6890	7194	44.4
CP79-318	7048	7497	7208	8108	7748	7683	7342	7555	7187	7486	66.7
LCP82-089	7011	5689	8359	8570	8126	7944	5580	7054	6229	7174	33.3
CP82-551	6693	6079	7161	7253	8029	8432	6424	7675	5734	7053	44.4
LCP83-153	7789	6691	8349	7393	8004	7463	4881	7361	6910	7205	33.3
CP84-730	8497	7147	9538	8525	9970	7748	8270	9138	8350	8539	100.0
LCP85-336	6444	6512	8108	7220	7690	8295	5729	7124	6143	7022	33.3
LCP85-376	6587	5291	7121	6590	6769	6861	5908	7067	6112	6479	11.1
LCP85-384	9739	7397	8618	8994	8598	9195	6600	8815	7850	8423	100.0
CP85-845	7657	6687	8186	7931	8420	8045	7485	7665	6677	7628	55.6
MEAN	7314	6722	7920	8050	7996	7813	6603	7642	6668	7417	55.6
MSD_{05}	801	1983	2497	1094	876	1438	2285	1333	1072	712	

[1] All - Allain; E.H. - Evan Hall; Mag - Magnolia; McL - McLeod; O.H. Oaklawn heavy soil; B.S. - Bon Secour; F.P - Frank Pearce; Geo - Georgia; R.H.- Ronald Hebert; O.L. - Oaklawn light soil; Lan - Lanaux.
[2] Percentage of locations where the variety was not significantly less than the highest yield variety at that location as determined the minimum significant difference ($P < 0.05$).

Table 3. Plant cane yield of cane for six commercial and seven experimental varieties at nine outfield locations in 1990.

	Heavy textured soil locations					Light textured soil locations					NS from
Variety	All.	E.H.	Mag.	McL.	O.H.	B.S.	F.P.	Geo.	R.H.	MEAN	Best
	tons/A										%
CP65-357	24.0	28.2	31.5	38.9	31.7	29.8	25.2	28.7	21.6	28.8	77.8
CP70-321	26.5	26.3	32.3	33.2	30.6	27.4	28.9	28.8	26.4	28.9	44.4
CP72-370	26.0	27.2	29.5	31.2	27.8	----	----	----	----	28.3	40.0
CP74-383	27.7	27.7	26.9	35.9	29.9	28.5	29.0	28.8	30.3	29.4	77.8
CP79-318	28.5	2[illegible]	27.7	33.8	31.4	30.9	28.1	29.5	29.3	29.5	77.8
LCP82-089	27.4	2[illegible]	.8	36.3	32.0	31.6	23.8	28.4	27.0	28.9	66.7
CP82-551	25.4	25.	9	32.6	32.3	31.9	24.2	30.0	26.2	28.4	66.7
LCP83-153	29.2	26.9		32.1	33.5	29.9	21.8	29.9	28.2	29.5	77.8
CP84-730	29.4	25.3		31.1	35.4	27.9	27.8	32.8	30.4	30.1	77.8
LCP85-336	23.5	24.0		35.0	30.4	32.3	23.2	29.3	26.8	28.5	66.7
LCP85-376	25.9	23.1	2 5	30.0	27.3	26.0	23.6	27.4	25.4	26.2	33.3
LCP85-384	36.6	28.4	32.1	36.7	32.6	32.9	24.9	32.1	32.3	32.1	100.0
CP85-845	30.0	27.9	33.4	35.2	33.5	32.6	28.6	30.0	30.1	31.1	88.9
MEAN	27.7	25.9	30.8	33.9	31.4	30.1	25.7	29.6	27.8	29.2	66.7
MSD_{05}	2.6	8.9	9.0	4.7	4.5	5.3	NS	4.2	4.1	2.2	

[1] All - Allain; E.H. - Evan Hall; Mag - Magnolia; McL - McLeod; O.H. Oaklawn heavy soil; B.S. - Bon Secour; F.P - Frank Pearce; Geo - Georgia; R.H.- Ronald Hebert; O.L. - Oaklawn light soil; Lan - Lanaux.
[2] Percentage of locations where the variety was not significantly less than the highest yield variety at that location as determined the minimum significant difference ($P < 0.05$).

Table 4. Plant cane sucrose content for six commercial and seven experimental varieties at nine outfield locations in 1990.

Variety	Heavy textured soil locations					Light textured soil locations				MEAN	NS from Best[2]
	All.[1]	E.H.	Mag.	McL.	O.H.	B.S.	F.P.	Geo.	R.H.		
	lbs/ton										%
CP65-357	271	231	257	237	266	255	249	264	247	253	11.1
CP70-321	266	299	266	240	256	269	272	255	250	264	33.3
CP72-370	268	267	261	249	254	---	---	---	---	260	20.0
CP74-383	257	244	242	244	245	251	240	254	228	245	0.0
CP79-318	247	285	260	240	247	249	261	256	246	255	11.1
LCP82-089	255	272	254	237	254	252	234	248	231	249	0.0
CP82-551	263	239	257	223	249	264	265	255	220	248	11.1
LCP83-153	267	248	245	231	240	250	225	246	245	244	0.0
CP84-730	289	283	303	275	282	279	299	277	276	284	100.0
LCP85-336	274	272	239	207	253	256	245	242	230	248	11.1
LCP85-376	254	232	256	220	249	264	251	258	241	247	22.2
LCP85-384	266	261	268	245	263	280	267	274	243	263	22.2
CP85-845	255	242	245	225	252	247	262	256	221	246	0.0
MEAN	264	260	257	238	254	260	256	257	240	254	0.0
$MSD_{.05}$	17	20	19	27	15	16	17	19	28	10	

[1] All - Allain; E.H. - Evan Hall; Mag - Magnolia; McL - McLeod; O.H. Oaklawn heavy soil; B.S. - Bon Secour; F.P - Frank Pearce; Geo - Georgia; R.H.- Ronald Hebert; O.L. - Oaklawn light soil; Lan - Lanaux.
[2] Percentage of locations where the variety was not significantly less than the highest yield variety at that location as determined the minimum significant difference ($P < 0.05$).

Table 5. Plant cane populations based on stalk counts for six commercial and seven experimental varieties at nine outfield locations in 1990.

Variety	Heavy textured soil locations					Light textured soil locations				MEAN	NS from Best[2]
	All.[1]	E.H.	Mag.	McL.	O.H.	B.S.	F.P.	Geo.	R.H.		
	stalks/A										%
CP65-357	17073	20600	23356	24512	22431	24627	15879	19463	13008	20106	22.2
CP70-321	19328	22065	19386	21178	22546	20407	18962	20003	16553	20048	22.2
CP72-370	18133	19579	19386	20350	19116	-----	-----	-----	-----	19313	20.0
CP74-383	21987	23780	18442	22392	20716	20523	21833	20234	18480	20932	22.2
CP79-318	21718	19136	21275	22643	22200	22373	19097	23163	18789	21155	22.2
LCP82-089	20311	16920	25919	25225	22431	24415	13990	22450	17093	20973	11.1
CP82-551	18172	19482	21082	22623	22103	23741	17787	24319	16322	20626	22.2
LCP83-153	23259	23471	25572	24666	25032	24493	14260	25206	20118	22897	22.2
CP84-730	16997	16515	19425	18962	18288	17170	15108	18134	16072	17330	11.1
LCP85-336	19078	19945	20831	24772	21660	25148	14202	22700	16842	20414	22.2
LCP85-376	19848	17767	20273	21217	20041	19617	15243	21583	18808	19377	11.1
LCP85-384	30890	25707	29561	28771	29098	29830	19694	29407	25553	27612	100.0
CP85-845	21467	21005	21564	23241	23240	23028	18654	20619	18172	21143	22.2
MEAN	20636	20459	22073	23071	22223	22948	17059	22273	17984	20986	22.2
$MSD_{.05}$	2845	7537	2394	2436	2865	3001	7934	3967	2766	1644	

[1] All - Allain; E.H. - Evan Hall; Mag - Magnolia; McL - McLeod; O.H. Oaklawn heavy soil; B.S. - Bon Secour; F.P - Frank Pearce; Geo - Georgia; R.H.- Ronald Hebert; O.L. - Oaklawn light soil; Lan - Lanaux.
[2] Percentage of locations where the variety was not significantly less than the highest yield variety at that location as determined the minimum significant difference ($P < 0.05$).

Table 6. Plant cane populations based on plot weights for six commercial and seven experimental varieties at nine outfield locations in 1990.

	Heavy textured soil locations					Light textured soil locations					NS from
Variety	All.[1]	E.H.	Mag.	McL.	O.H.	B.S.	F.P.	Geo.	R.H.	MEAN	Best[2]
	stalks/A										%
CP65-357	17723	24253	18472	22505	22814	23174	17520	21925	17284	20630	33.3
CP70-321	19369	20451	19429	21272	23625	19747	21612	20901	17880	20476	22.2
CP72-370	19341	20906	19886	18780	21543	-----	-----	-----	-----	20091	20.0
CP74-383	24788	25173	16963	22701	22355	21993	25211	20874	20570	22292	22.2
CP79-318	20536	19646	16798	20689	22359	22275	20796	21463	20124	20521	11.1
LCP82-089	20608	17845	22278	21953	22498	23169	17995	24174	19369	21099	33.3
CP82-551	22685	25736	21845	23888	27046	26487	22789	25537	22173	24243	55.6
LCP83-153	26207	25257	25275	24539	27195	23115	19908	25982	22817	24477	77.8
CP84-730	19591	17571	18570	16728	21663	17336	17113	19811	20283	18747	11.1
LCP85-336	18455	23406	22058	21292	21543	24255	18733	22034	19069	21202	44.4
LCP85-376	19374	19586	20746	20128	19952	20690	17713	24463	21185	20426	22.2
LCP85-384	30031	30067	23639	27462	27896	27925	21571	29782	29563	27548	100.0
CP85-845	24498	24038	21808	25032	27383	25778	23467	27087	21130	24447	77.8
MEAN	21785	22610	20651	22016	23683	22995	20369	23669	20954	22089	22.2
MSD.05	3255	7176	5922	3229	3974	4887	8463	3821	3917	1630	

[1] All - Allain; E.H. - Evan Hall; Mag - Magnolia; McL - McLeod; O.H. Oaklawn heavy soil; B.S. - Bon Secour; F.P - Frank Pearce; Geo - Georgia; R.H.- Ronald Hebert; O.L. - Oaklawn light soil; Lan - Lanaux.
[2] Percentage of locations where the variety was not significantly less than the highest yield variety at that location as determined the minimum significant difference ($P < 0.05$).

Table 7. Plant cane stalk weights for six commercial and seven experimental varieties at nine outfield locations in 1990.

	Heavy textured soil locations					Light textured soil locations					NS from
Variety	All.[1]	E.H.	Mag.	McL.	O.H.	B.S.	F.P.	Geo.	R.H.	MEAN	Best[2]
	lbs										%
CP65-357	2.73	2.34	3.42	3.46	2.78	2.57	2.87	2.62	2.50	2.81	33.3
CP70-321	2.74	2.58	3.34	3.14	2.59	2.78	2.68	2.75	2.97	2.84	44.4
CP72-370	2.68	2.60	2.96	3.34	2.59	----	----	----	----	2.84	20.0
CP74-383	2.26	2.20	3.19	3.17	2.68	2.59	2.33	2.76	2.94	2.68	22.2
CP79-318	2.79	2.68	3.28	3.27	2.82	2.78	2.71	2.76	2.91	2.89	44.4
LCP82-089	2.66	2.34	2.94	3.31	2.86	2.73	2.66	2.35	2.79	2.74	11.1
CP82-551	2.24	1.96	2.54	2.74	2.40	2.42	2.13	2.35	2.36	2.35	0.0
LCP83-153	2.23	2.12	2.70	2.62	2.46	2.60	2.17	2.31	2.49	2.41	0.0
CP84-730	3.02	2.88	3.39	3.72	3.27	3.22	3.25	3.31	3.01	3.22	100.0
LCP85-336	2.55	2.07	3.08	3.30	2.82	2.68	2.48	2.66	2.80	2.69	11.1
LCP85-376	2.68	2.36	2.64	2.98	2.73	2.52	2.66	2.24	2.45	2.59	0.0
LCP85-384	2.46	1.91	2.72	2.68	2.36	2.37	2.30	2.16	2.19	2.35	0.0
CP85-845	2.45	2.36	3.08	2.82	2.45	2.56	2.44	2.24	2.86	2.58	11.1
MEAN	2.57	2.34	3.01	3.12	2.68	2.65	2.56	2.54	2.69	2.68	11.1
MSD.05	0.30	0.30	0.28	0.36	0.29	0.43	0.30	0.27	0.43	0.13	

[1] All - Allain; E.H. - Evan Hall; Mag - Magnolia; McL - McLeod; O.H. Oaklawn heavy soil; B.S. - Bon Secour; F.P - Frank Pearce; Geo - Georgia; R.H.- Ronald Hebert; O.L. - Oaklawn light soil; Lan - Lanaux.
[2] Percentage of locations where the variety was not significantly less than the highest yield variety at that location as determined the minimum significant difference ($P < 0.05$).

Table 8. First ratoon sucrose yield for seven commercial and three experimental varieties at seven outfield locations in 1990.

	Hvy. textured soil locations		Light textured soil locations						NS from
Variety	All.[1]	Mag.	B.S.	F.P.	Geo.	O.L.	R.H.	MEAN	Best[2]
	lbs/A								%
CP65-357	----	5849	5891	5403	4950	2569	4698	4893	16.7
CP70-321	7469	8954	6483	6466	7407	4158	6155	6728	100.0
CP72-370	7585	6822	----	----	----	----	----	7204	50.0
CP74-383	8240	8171	7139	6484	7751	4924	5488	6885	100.0
CP76-331	----	----	7482	5290	7853	5140	5939	6341	100.0
CP79-318	7549	7225	6724	6035	7425	5064	5225	6464	85.7
LCP82-089	7903	8293	6033	----	6924	3953	4941	6341	66.7
CP82-551	7157	7751	6999	6108	7719	4391	6644	6681	85.7
LCP83-153	8279	7126	7535	6841	8225	5213	6786	7143	85.7
CP84-730	7305	9005	6784	6438	8758	4645	6926	7123	85.7
MEAN	7686	7689	6785	6133	7446	4451	5867	6569	100.0
$MSD_{.05}$	873	1646	1166	NS	1713	2421	1994	680	

[1] All - Allain; E.H. - Evan Hall; Mag - Magnolia; McL - McLeod; O.H. Oaklawn heavy soil; B.S. - Bon Secour; F.P - Frank Pearce; Geo - Georgia; R.H.- Ronald Hebert; O.L. - Oaklawn light soil; Lan - Lanaux.
[2] Percentage of locations where the variety was not significantly less than the highest yield variety at that location

Table 9. First ratoon cane yield for seven commercial and three experimental varieties at seven outfield locations in 1990.

	Hvy. textured soil locations		Light textured soil locations						NS from
Variety	All.[1]	Mag.	B.S.	F.P.	Geo.	O.L.	R.H.	MEAN	Best[2]
	tons/A								%
CP65-357	----	26.4	24.6	21.5	18.3	12.9	18.3	20.3	33.3
CP70-321	26.1	36.2	24.2	23.1	27.8	17.8	22.9	25.5	71.4
CP72-370	27.5	28.1	----	----	----	----	----	27.8	0.0
CP74-383	30.8	36.3	29.8	27.5	29.2	22.5	21.5	28.2	100.0
CP76-331	----	----	28.0	21.1	29.7	22.7	22.0	24.7	100.0
CP79-318	27.5	29.9	26.6	24.8	27.4	23.5	20.5	25.8	71.4
LCP82-089	28.0	35.2	24.6	----	27.8	20.1	21.3	26.1	83.3
CP82-551	26.1	33.0	28.7	24.0	29.5	21.7	27.1	27.2	85.7
LCP83-153	30.0	30.9	29.9	29.5	31.0	24.4	27.1	29.0	100.0
CP84-730	24.7	33.9	24.1	22.5	29.5	19.3	25.3	25.6	71.4
MEAN	27.6	32.2	26.7	24.3	27.8	20.5	22.9	26.0	85.7
$MSD_{.05}$	3.1	6.1	3.3	NS	5.2	12.5	7.8	2.7	

[1] All - Allain; E.H. - Evan Hall; Mag - Magnolia; McL - McLeod; O.H. Oaklawn heavy soil; B.S. - Bon Secour; F.P - Frank Pearce; Geo - Georgia; R.H.- Ronald Hebert; O.L. - Oaklawn light soil; Lan - Lanaux.
[2] Percentage of locations where the variety was not significantly less than the highest yield variety at that location

Table 10. First ratoon sucrose content for seven commercial and three experimental varieties at seven outfield locations in 1990.

Variety	Hvy. textured soil locations		Light textured soil locations					MEAN	NS from Best[2]
	All.[1]	Mag.	B.S.	F.P.	Geo.	O.L.	R.H.		
	lbs/ton								%
CP65-357	---	219	240	250	270	195	256	238	16.7
CP70-321	287	247	268	278	266	234	268	264	85.7
CP72-370	276	244	---	---	---	---	---	260	0.0
CP74-383	268	225	239	233	266	219	255	244	14.3
CP76-331	---	---	267	252	265	228	270	256	60.0
CP79-318	274	240	252	243	270	216	255	250	14.3
LCP82-089	283	235	245	---	249	196	233	240	16.7
CP82-551	274	235	244	255	261	204	244	245	0.0
LCP83-153	276	231	252	232	265	215	251	246	14.3
CP84-730	296	266	281	285	296	243	276	278	100.0
MEAN	279	238	254	253	268	217	256	252	14.3
$MSD_{.05}$	15	20	25	19	20	22	31	9	

[1] All - Allain; E.H. - Evan Hall; Mag - Magnolia; McL - McLeod; O.H. Oaklawn heavy soil; B.S. - Bon Secour; F.P - Frank Pearce; Geo - Georgia; R.H.- Ronald Hebert; O.L. - Oaklawn light soil; Lan - Lanaux.
[2] Percentage of locations where the variety was not significantly less than the highest yield variety at that location

Table 11. First ratoon populations based on stalk counts for seven commercial and three experimental varieties at seven outfield locations in 1990.

Variety	Hvy. textured soil locations		Light textured soil locations					MEAN	NS from Best
	All.	Mag.	B.S.	F.P.	Geo.	O.L.	R.H.		
	stalks/A								%
CP65-357	-----	18191	21795	10676	12969	8421	-----	14410	0.0
CP70-321	23221	24685	23298	15147	23452	12641	-----	20407	66.7
CP72-370	23298	19193	-----	-----	-----	-----	-----	21246	50.0
CP74-383	28366	25649	27036	16630	24686	20484	-----	23809	83.3
CP76-331	-----	-----	23992	10464	21814	17786	-----	18514	25.0
CP79-318	23934	20350	25128	16765	22238	21371	-----	21631	66.7
LCP82-089	23163	26150	22180	-----	24435	16746	-----	22535	80.0
CP82-551	23183	25456	27730	15416	26034	18442	-----	22710	100.0
LCP83-153	26362	22912	29831	19848	27094	22373	-----	24737	100.0
CP84-730	17536	19733	19694	11890	20080	12314	-----	16875	0.0
MEAN	23633	22480	24521	14605	22534	16731	-----	20813	83.3
$MSD_{.05}$	6162	3771	2678	7800	4869	8247	----	2683	

[1] All - Allain; E.H. - Evan Hall; Mag - Magnolia; McL - McLeod; O.H. Oaklawn heavy soil; B.S. - Bon Secour; F.P - Frank Pearce; Geo - Georgia; R.H.- Ronald Hebert; O.L. - Oaklawn light soil; Lan - Lanaux.
[2] Percentage of locations where the variety was not significantly less than the highest yield variety at that location

Table 12. First ratoon populations based on plot weights for seven commercial and three experimental varieties at seven outfield locations in 1990.

Variety	Hvy. textured soil locations		Light textured soil locations					MEAN	NS from Best[2]
	All.[1]	Mag.	B.S.	F.P.	Geo.	O.L.	R.H.		
	stalks/A								%
CP65-357	-----	18383	21287	18293	13701	12379	18678	17120	16.7
CP70-321	24898	26072	22650	18478	21659	17452	18085	21328	42.9
CP72-370	26930	22961	-----	-----	-----	-----	-----	24946	0.0
CP74-383	34108	28108	29291	26889	28516	22455	23472	27548	85.7
CP76-331	-----	-----	21461	18574	22242	20584	21166	20805	40.0
CP79-318	24614	20813	24963	21377	22847	21081	17567	21895	28.6
LCP82-089	25148	25830	22248	-----	24906	20744	20710	23264	50.0
CP82-551	25316	29711	27902	24833	26335	25195	29195	26927	85.7
LCP83-153	26837	23056	29835	29115	26013	25110	28938	26986	71.4
CP84-730	20270	23470	20150	19053	22289	15108	20310	20093	28.6
MEAN	26015	24267	24421	22077	23168	20012	22013	23109	28.6
$MSD_{.05}$	4352	4231	3665	12520	4268	10775	5011	2706	

[1] All - Allain; E.H. - Evan Hall; Mag - Magnolia; McL - McLeod; O.H. Oaklawn heavy soil; B.S. - Bon Secour; F.P - Frank Pearce; Geo - Georgia; R.H.- Ronald Hebert; O.L. - Oaklawn light soil; Lan - Lanaux.
[2] Percentage of locations where the variety was not significantly less than the highest yield variety at that location

Table 13. First ratoon stalk weights for seven commercial and three experimental varieties at seven outfield locations in 1990.

Variety	Hvy. textured soil locations		Light textured soil locations					MEAN	NS from Best[2]
	All.[1]	Mag.	B.S.	F.P.	Geo.	O.L.	R.H.		
	lbs								%
CP65-357	----	2.89	2.32	2.36	2.66	2.03	1.97	2.37	50.0
CP70-321	2.11	2.79	2.15	2.50	2.57	2.03	2.54	2.38	57.1
CP72-370	2.05	2.45	----	----	----	----	----	2.25	0.0
CP74-383	1.80	2.60	2.04	2.02	2.06	2.00	1.83	2.05	14.3
CP76-331	----	----	2.63	2.28	2.67	2.22	2.08	2.38	60.0
CP79-318	2.24	2.88	2.14	2.34	2.41	2.22	2.34	2.37	57.1
LCP82-089	2.23	2.74	2.21	----	2.24	1.95	2.05	2.24	33.3
CP82-551	2.06	2.22	2.06	1.93	2.24	1.73	1.86	2.02	0.0
LCP83-153	2.25	2.68	2.01	2.02	2.39	1.96	1.87	2.17	28.6
CP84-730	2.45	2.89	2.40	2.36	2.65	2.55	2.47	2.54	100.0
MEAN	2.15	2.68	2.22	2.23	2.43	2.08	2.11	2.27	14.3
$MSD_{.05}$	0.27	0.33	0.25	0.26	0.19	0.22	0.28	0.16	

[1] All - Allain; E.H. - Evan Hall; Mag - Magnolia; McL - McLeod; O.H. Oaklawn heavy soil; B.S. - Bon Secour; F.P - Frank Pearce; Geo - Georgia; R.H.- Ronald Hebert; O.L. - Oaklawn light soil; Lan - Lanaux.
[2] Percentage of locations where the variety was not significantly less than the highest yield variety at that location

Table 14. Second ratoon sucrose yield for six commercial and two experimental varieties at four outfield locations in 1990.

Variety	Hvy. textured soil locations		Light textured soil locations		MEAN	NS from Best[2]
	Mag.[1]	O.H.	Geo.	Lan.		
	lbs/A				%	
CP65-357	6438	2637	4476	4792	4586	50.0
CP70-321	3714	2425	5216	3636	3748	25.0
CP74-383	5625	3391	4884	5867	4942	75.0
CP76-331	5010	3414	6562	4708	4923	50.0
CP79-318	7084	4914	6135	4662	5699	75.0
LCP82-089	5893	3240	5604	3668	4601	50.0
CP82-551	6091	4525	5540	6541	5674	100.0
LCP83-153	6403	5520	5362	5442	5682	100.0
MEAN	5779	3758	5473	4915	4981	50.0
$MSD_{.05}$	2323	1129	2286	1388	1323	

[1] All - Allain; E.H. - Evan Hall; Mag - Magnolia; McL - McLeod; O.H. Oaklawn heavy soil; B.S. - Bon Secour; F.P - Frank Pearce; Geo - Georgia; R.H.- Ronald Hebert; O.L. - Oaklawn light soil; Lan - Lanaux.

[2] Percentage of locations where the variety was not significantly less than the highest yield variety at that location

Table 15. Second ratoon yield of cane for six commercial and two experimental varieties at four outfield locations in 1990.

Variety	Hvy. textured soil locations		Light textured soil locations		MEAN	NS from Best[2]
	Mag.[1]	O.H.	Geo.	Lan.		
	tons/A					%
CP65-357	27.3	13.3	21.5	21.6	20.9	50.0
CP70-321	14.9	11.8	24.5	17.2	17.1	25.0
CP74-383	25.0	16.6	25.1	26.8	23.4	75.0
CP76-331	20.1	15.3	29.2	21.1	21.4	50.0
CP79-318	27.3	22.3	28.7	20.7	24.7	50.0
LCP82-089	23.0	16.3	28.1	17.7	21.3	50.0
CP82-551	25.8	21.2	28.0	29.2	26.1	75.0
LCP83-153	28.0	26.3	27.2	24.1	26.4	100.0
MEAN	23.9	17.9	26.5	22.3	22.7	50.0
$MSD_{.05}$	10.5	5.0	NS	5.6	5.1	

[1] All - Allain; E.H. - Evan Hall; Mag - Magnolia; McL - McLeod; O.H. Oaklawn heavy soil; B.S. - Bon Secour; F.P - Frank Pearce; Geo - Georgia; R.H.- Ronald Hebert; O.L. - Oaklawn light soil; Lan - Lanaux.

[2] Percentage of locations where the variety was not significantly less than the highest yield variety at that location

Table 16. Second ratoon sucrose content for six commercial and two experimental varieties at four outfield locations in 1990.

Variety	Hvy. textured soil locations		Light textured soil locations		MEAN	NS from Best[2]
	Mag.[1]	O.H.	Geo.	Lan.		
	lbs/ton					%
CP65-357	241	200	212	222	218	100.0
CP70-321	244	203	213	212	218	100.0
CP74-383	227	205	195	219	211	75.0
CP76-331	253	224	224	223	231	100.0
CP79-318	260	221	214	225	230	100.0
LCP82-089	257	198	199	204	214	75.0
CP82-551	238	214	198	224	218	75.0
LCP83-153	230	210	198	225	216	75.0
MEAN	244	209	206	219	220	100.0
$MSD_{.05}$	42	31	21	NS	14	

[1] All - Allain; E.H. - Evan Hall; Mag - Magnolia; McL - McLeod; O.H. Oaklawn heavy soil; B.S. - Bon Secour; F.P - Frank Pearce; Geo - Georgia; R.H.- Ronald Hebert; O.L. - Oaklawn light soil; Lan - Lanaux.

[2] Percentage of locations where the variety was not significantly less than the highest yield variety at that location.

Table 17. Second ratoon populations based on stalk counts for six commercial and two experimental varieties at four outfield locations in 1990.

Variety	Hvy. textured soil locations		Light textured soil locations		MEAN	NS from Best[2]
	Mag.[1]	O.H.	Geo.	Lan.		
	stalks/A					%
CP65-357	24165	----	15436	12449	17350	66.7
CP70-321	20196	----	17151	10348	15898	66.7
CP74-383	20022	----	21140	18538	19900	100.0
CP76-331	17286	----	20870	11909	16688	66.7
CP79-318	13393	----	20446	14723	16187	66.7
LCP82-089	27364	----	20947	8942	19084	66.7
CP82-551	21506	----	23741	20503	21917	100.0
LCP83-153	20349	----	23028	18770	20716	100.0
MEAN	20535	----	20345	14523	18467	66.7
$MSD_{.05}$	14008	----	9605	3778	NS	

[1] All - Allain; E.H. - Evan Hall; Mag - Magnolia; McL - McLeod; O.H. Oaklawn heavy soil; B.S. - Bon Secour; F.P - Frank Pearce; Geo - Georgia; R.H.- Ronald Hebert; O.L. - Oaklawn light soil; Lan - Lanaux.

[2] Percentage of locations where the variety was not significantly less than the highest yield variety at that location.

Table 18. Second ratoon populations based on plot weights for six commercial and two experimental varieties at four outfield locations in 1990.

Variety	Hvy. textured soil locations		Light textured soil locations		MEAN	NS from Best[2]
	Mag.[1]	O.H.	Geo.	Lan.		
	stalks/A					%
CP65-357	28627	12305	17332	18546	19203	25.0
CP70-321	13336	11951	18457	15787	14883	0.0
CP74-383	27005	20605	24326	23992	23982	75.0
CP76-331	16725	14839	24072	16616	18063	25.0
CP79-318	21815	23886	22968	17987	21664	75.0
LCP82-089	23342	17261	24312	15624	20135	50.0
CP82-551	27725	27568	28951	27747	27725	100.0
LCP83-153	27602	29540	26157	23206	26626	100.0
MEAN	23123	19744	23322	19938	21532	50.0
$MSD_{.05}$	7373	7939	8763	5452	4993	

[1] All - Allain; E.H. - Evan Hall; Mag - Magnolia; McL - McLeod; O.H. Oaklawn heavy soil; B.S. - Bon Secour; F.P - Frank Pearce; Geo - Georgia; R.H.- Ronald Hebert; O.L. - Oaklawn light soil; Lan - Lanaux.

[2] Percentage of locations where the variety was not significantly less than the highest yield variety at that location.

Table 19. Second ratoon stalk weights for six commercial and two experimental varieties at four outfield locations in 1990.

Variety	Hvy. textured soil locations		Light textured soil locations		MEAN	NS from Best[2]
	Mag.[1]	O.H.	Geo.	Lan.		
	lbs					%
CP65-357	1.90	2.16	2.52	2.35	2.23	75.0
CP70-321	2.21	1.97	2.67	2.18	2.26	100.0
CP74-383	1.85	1.61	2.08	2.26	1.95	25.0
CP76-331	2.32	2.12	2.42	2.55	2.35	100.0
CP79-318	2.50	1.86	2.50	2.32	2.30	100.0
LCP82-089	1.97	1.89	2.32	2.23	2.10	50.0
CP82-551	1.95	1.57	1.94	2.11	1.89	25.0
LCP83-153	2.04	1.82	2.08	2.08	2.00	50.0
MEAN	2.09	1.88	2.32	2.26	2.14	75.0
$MSD_{.05}$	0.45	0.44	0.30	0.49	0.23	

[1] All - Allain; E.H. - Evan Hall; Mag - Magnolia; McL - McLeod; O.H. Oaklawn heavy soil; B.S. - Bon Secour; F.P - Frank Pearce; Geo - Georgia; R.H.- Ronald Hebert; O.L. - Oaklawn light soil; Lan - Lanaux.

[2] Percentage of locations where the variety was not significantly less than the highest yield variety at that location.

Table 20. The number of outfield plant cane locations in which the variety was rated in the designated category.

	Pre-Harvest Erectness				Post-Harvest Scrap			
Variety	Erect	Leaning	Opened	Lodged	None	Little	Much	V.Much
CP65-357	8			1	7	1	1	
CP70-321	8			1	8	1		
CP72-370	4	1			3	2		
CP74-383	8	1			7	2		
CP76-331	1				1			
CP79-318	7			2	5	3		1
LCP82-089	5	2	2		7	2		
CP82-551	7	1		1	5	2	1	1
LCP83-153	5	1	2	1	5	4		
CP84-730	7	1		1	5	2	1	1
LCP85-336	4	1	3	1	6	3		
LCP85-376	4	1	2	2	6	1	2	
LCP85-384	7			2	6	2	1	
CP85-845	7	2			7	1		1

Table 21. The number of outfield first ratoon locations in which the variety was rated in the designated category.

	Pre-Harvest Erectness				Post-Harvest Scrap			
Variety	Erect	Leaning	Opened	Lodged	None	Little	Much	V.Much
CP65-357	6				6			
CP70-321	6				7			
CP72-370	3				3			
CP74-383	7				7			
CP76-331	4				4			
CP79-318	7				6	1		
LCP82-089	6				6			
CP82-551	7				6	1		
LCP83-153	7				7			
CP84-730	7				7			

Table 22. The number of outfield second ratoon locations in which the variety was rated in the designated category.

	Pre-Harvest Erectness				Post-Harvest Scrap			
Variety	Erect	Leaning	Opened	Lodged	None	Little	Much	V.Much
CP65-357	4				4			
CP70-321	4				4			
CP74-383	4				4			
CP76-331	4				4			
CP79-318	4				4			
LCP82-089	4				4			
CP82-551	4				3		1	
LCP83-153	4				4			

Table 23. Three year outfield summary of erectness and postharvest scrappiness of tested sugarcane varieties.

	Pre-Harvest Erectness				Post-Harvest Scrap			
Variety	Erect	Leaning	Opened	Lodged	None	Little	Much	V.Much
CP65-357	52[1]	3	0	2	55	1	1	0
	(91)	(5)		(4)	(96)	(2)	(2)	
CP70-321	48	5	0	6	53	4	2	0
	(81)	(9)		(10)	(90)	(7)	(3)	
CP72-370	11	1	0	0	10	2	0	0
	(92)	(8)			(83)	(17)		
CP74-383	54	4	0	1	57	2	0	0
	(92)	(7)		(2)	(97)	(3)		
CP76-331	34	5	0	4	28	11	4	0
	(79)	(12)		(9)	(65)	(26)	(9)	
CP79-318	45	5	2	6	43	9	5	1
	(78)	(9)	(4)	(10)	(74)	(16)	(9)	(2)
LCP82-089	45	10	2	1	56	2	0	0
	(78)	(17)	(4)	(2)	(97)	(4)		
CP82-551	53	3	0	3	32	18	7	2
	(90)	(5)		(5)	(54)	(31)	(12)	(3)
LCP83-153	48	5	2	4	43	13	2	1
	(81)	(9)	(3)	(7)	(73)	(22)	(3)	(2)

[1] Number and (percentage) variety rated in given catagory.

USE OF A MODIFIED AUGMENTED DESIGN IN THE UNREPLICATED STAGES OF SUGARCANE SELECTION

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Summary

Early stages of clonal selection in the Louisiana Sugarcane Variety Development Program (LSVDP) test large numbers of genotypes for commercial variety potential. Resource demands limit evaluation to unreplicated tests. Such testing confounds the environmental effects with genotypic effects and limits the amount of objective data that can be collected. A study was initiated to test the effectiveness of the modified augmented design (MAD) in selecting unreplicated clonal plots.

Data were collected from two crossing series, the 1985 and 1986 first and second clonal trials, and an additional replicated increase clonal test of the 1985 series.

Use of the MAD improved the correlation of sucrose and cane yield between the two unreplicated test stages of the 1985 crossing series but not the 1986 crossing series. 1985 crossing series first-clonal and second-clonal trial traits were poorly correlated with replicated increase means. Use of the MAD did not improve the correlations. A severe freeze in 1989 may have affected the results. Although there was no statistical justification for use of the MAD, the researchers felt the proximate locality of control plots aided in unreplicated selection decisions.

Introduction

The study focused on the selection decisions to advance from the second-clonal trials to the increase stage. These advancement decisions use first-ratoon first-clonal trial data and plant-cane second-clonal trial data. Data is collected only on clones that are advanced to the second-clonal trials. The objective of this study was to evaluate the ability of the MAD to improve the selection efficiency among the unreplicated stages of the LSVDP.

Materials and Methods

In fall 1989, data were collected from 618 experimental clones in the first-ratoon first-clonal trials and from the plant-cane second-clonal trials for the 1985 crossing series. Data was also collected from the 144 check plots in the first-clonal trials and the 24 check plots in the second-clonal trials. The data collected were: stalk number, stalk diameter of three stalks, stalk length and smut incidence. Erect second-clonal genotypes with sufficient stalk number and estimated stalk weight (from the length and diameter), without smut or pith were hand Brixed. Clones with sufficient Brix and with sufficient stalk number in the first-clonal trials were advanced to the increase stage.

Check plots and plots of those clones advanced were sampled from both trials for stalk weight and sucrose analysis. One-hundred fifty randomly selected clones from those advanced to the increase plots were replicated in two blocks in a RCB design at the St. Gabriel Research Station and in the same manner at the Iberia Research Station. Stalk number, stalk weight and sucrose analysis were recorded in the fall of 1990. First and second clonal trials were planted in 1987 and 1988, respectively, in mainplots with 25 subplots (five plots wide by five plots long). The center subplot was the check variety, CP70-321. The single row plots were 1.83m long with 0.61 alleys in the first clonal plots and were 4.88m long with 1.22 alleys in the second clonal and replicated increase plots. Rows were on 1.83 centers. Using check plot data only, unreplicated observations were adjusted by the deviation of the row mean from the overall mean and the deviation of the column mean from the overall mean (Lin and Poushinsky, 1983).

The entire study was repeated using the 1986 crossing series that was planted in first-clonal and second clonal trials during 1988 and 1989, respectively. Stalk number and diameter were recorded for the 913 first-clonal first-ratoon and second-clonal plant-cane experimental clones in addition to 141 first-clonal and 42 second-clonal checks. A sucrose analysis will be performed on the 263 clones advanced to increase trials. The increase stage was replicated two times at the St. Gabriel Research Station. Stalk number, stalk weight and sucrose analysis results will be recorded on the replicated plots.

Results and Discussion

Use of the MAD minimally improved the correlation of sucrose yield and cane yield between the first clonal and second clonal stages in the 1985 series but not in the 1986 series (Table 1). Correlations of the other traits were not affected by adjusting with the MAD. The improved correlations of sucrose and cane yield in the 1985 series suggests the MAD adjustment were removing some of the environmental error in the unreplicated tests. A record freeze in December 1989 damaged the plots and probably affected the correlations in the 1986 series comparison.

Combinations of adjusted and unadjusted first and second clonal data were poorly correlated with the mean of all replicated increase trials (Table 2) and with the mean of the St. Gabriel increase trial (Table 3). Use of the MAD did not significantly affect these correlations. This suggests its use in the clonal trials will not improve the efficiency of the selection process. Again, the record freeze likely affected these results. Despite the results, the researchers felt the proximate locality of control plots aided in unreplicated selection decisions and thus the planting arrangement was considered beneficial.

Acknowledgment

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References

Lin, C. S. and G. Poushinsky. 1983. A modified augmented design for early stages of plant selection involving a large number of test lines without replication. Biometrics 39:553-561.

Table 1. Correlations of traits between first-clonal and second-clonal trials with and without using the row-column MAD adjustment.

	Crossing Series	Sucrose yield	Cane yield	Stalk no.	Stalk wt.	Stalk diam.	Stalk length	Sucrose content
Unadj.	1985	0.10 ±0.07	0.13 ±0.06	0.36 ±0.04	0.51 ±0.06	0.47 ±0.04	0.30 ±0.04	0.10 ±0.07
	1986	0.21 ±0.06	0.23 ±0.06	0.16 ±0.03	0.60 ±0.06	0.14 ±0.03	NA NA	0.25 ±0.06
Adj.	1985	0.19 ±0.07	0.21 ±0.07	0.31 ±0.04	0.54 ±0.07	0.43 ±0.04	0.33 ±0.04	0.10 ±0.07
	1986	0.17 ±0.06	0.17 ±0.06	0.17 ±0.03	0.48 ±0.06	0.14 ±0.03	NA NA	0.25 ±0.06

Table 2. Multiple correlation coefficients for traits between first-clonal and second-clonal trials, and the mean of all replicated increase trials.

First clonal	Second clonal	Sucrose yield	Cane yield	Stalk no.	Stalk wt.	Stalk diam.	Stalk length	Sucrose content
Unadj.	Unadj.	0.17 ±0.09	0.04 ±0.09	0.32 ±0.09	0.07 ±0.09	0.25 ±0.09	0.32 ±0.09	0.26 ±0.09
Unadj.	Adj.	0.11 ±0.09	0.05 ±0.09	0.28 ±0.09	0.04 ±0.09	0.24 ±0.09	0.32 ±0.09	0.27 ±0.09
Adj.	Unadj.	0.09 ±0.09	0.06 ±0.09	0.33 ±0.09	0.09 ±0.09	0.25 ±0.09	0.31 ±0.09	0.23 ±0.09
Adj.	Adj.	0.17 ±0.09	0.07 ±0.09	0.29 ±0.09	0.07 ±0.09	0.25 ±0.09	0.31 ±0.09	0.23 ±0.09

Table 3. Multiple correlation coefficients for traits between first-clonal and second-clonal trials, and the mean of the St. Gabriel increase trial.

First clonal	Second clonal	Sucrose yield	Cane Yield	Stalk no.	Stalk wt.	Stalk diam.	Stalk length	Sucrose content
Unadj.	Unadj.	0.17 ±0.09	0.15 ±0.09	0.18 ±0.09	0.21 ±0.09	0.07 ±0.09	0.16 ±0.09	0.10 ±0.09
Unadj.	Adj.	0.21 ±0.09	0.15 ±0.09	0.14 ±0.09	0.21 ±0.09	0.12 ±0.09	0.16 ±0.09	0.10 ±0.09
Adj.	Unadj.	0.20 ±0.09	0.20 ±0.09	0.18 ±0.09	0.23 ±0.09	0.07 ±0.09	0.14 ±0.09	0.06 ±0.09
Adj.	Adj.	0.23 ±0.09	0.20 ±0.09	0.16 ±0.09	0.23 ±0.09	0.12 ±0.09	0.15 ±0.09	0.06 ±0.09

SUGARCANE CROSS APPRAISAL

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Summary

A quick, accurate method to appraise a cross's potential to produce elite clones is needed. The current method uses the percent advancement of the original seedlings planted that are selected and replanted in more advanced stages of testing. It requires four to five years and thus prevents selection among families in the field and is rather late to use in generating new crosses. A study to develop a practical cross appraisal method was initiated by appraising 1800 progeny from 15 crosses among 23 parents at two intrarow plant spacings. It was hypothesized that wider intrarow spacing would increase the variability of cross progeny.

The study showed the probability to produce an elite clone was accurately predicted by the mean value alone. It also suggested that family worth estimates based upon single stool data reasonable correlated to the family worth estimates based upon clonal plots. The research suggested that use of wider intrarow spacing among seedlings would enhanced the variability family for stool weight. Correlations among the plant cane seedlings and the first ratoon seedlings with the clonal plot estimates suggested the plant cane estimates could in many cases be used to make family cross appraisal estimates.

Objectives

Objectives of this study were to identify the most accurate statistic to predict the potential of a cross to produce elite progeny and to verify that single-stool-based family appraisal estimates for cane yield reasonably predict the family's cane yield potential based upon clonal plot data. An additional objective was to test the effect of intrarow plant spacing on cross variability.

Materials and Methods

One-hundred twenty progeny each from 15 biparental crosses among 23 parents were evaluated in plant cane seedlings at the St. Gabriel Research Station. The seedlings were planted in three replications at two intrarow spacings (the standard 41cm, and 82cm) in 1988. Each plot consisted of two rows (1.83m centers) with 10 plants on each row. Additional plants were included to buffer the test plants and to equalized row size. On a single stool basis, stalk number, mid-stalk diameter of three stalks, stalk length and hand Brix were collected. To appraise the correlation between stool based cane yield estimates and clonal plot cane yield estimates, two stalks from each of sixty random progeny were harvested and planted from each cross in 1989. The progeny and their parents were planted with no family structure in a RCB design using three blocks.

Data were collected in 1989 from plant cane seedling plots (PC), in 1990 from first ratoon seedling plots (FR) and in 1990 from first clonal plots (FC). Heavy johnson grass pressure and a record freeze in December, 1989 severely affected all plots. Thus the study is likely a worse case scenario.

Full-sib family means (MEAN), variances and the probability (PROB) to transgress a target value were estimated. The PROB was estimated using the Z statistic for a normal probability (Steel and Torrie, 1980) as:

$Z = (mean_i - target)/SD_i$

where the $mean_i$ and SD_i were the full-sib family mean and standard deviation, respectively, of family i. Best linear unbiased predictors (BLUP) were also calculated (Henderson, 1984). This mixed model method uses genetic information from relatives and in this case used the additive genetic relationships between the genotypes. This genetic information is weighted by the trait's heritability and theoretically should be the best predictor of family worth.

Results and Discussion

The correlations among the statistics (OBS, MEAN, PROB, BLUP) within the three tests (PC, FR and FC) were generally very strong ($r > 0.80$) (Tables 1-6). This suggested that the basic assumptions of normality were reasonably valid and that regardless of the statistic, they ranked the families in similar manner. The correlations among the tests were smaller than within the tests and varied somewhat with the trait and statistic.

Analysis of variance for the standard deviation of traits suggested the variance differed among crosses for all traits in the PC. Cross variance was significantly different for the stalk number and stalk weight in the FR and was significant for Brix in the clonal plots (Table 7). Intrarow spacing was significant for stool weight in the PC and FR, and was significant for the stalk length in the PC. The mean standard deviation of crosses larger in wider intrarow spacings than in narrow row spacings in both the PC and FR tests (2.25 N vs. 2.99 W, PC; 6.03 N vs. 7.35 W, FR). The standard deviation of stalk length was smaller at wide spacings than narrow spacings (0.40 N vs. 0.37 W). Cross by spacing interaction was significant for stalk length in the PC. This suggests that planting seedlings at wider intrarow spacing would enhance selection ability. The finding that crosses may vary in their variance among progeny for certain traits suggests collection of data to allow calculation of PROBs and BLUP would enhance selection among families. The strong correlations of OBS with MEAN, PROB and BLUP within a stage does not, however, support this contention (Tables 1-6). It is logistically easier to obtain the MEAN in the field than the PROB or the BLUP and appears to sacrifice little predictive ability compared to the PROB or BLUP. This suggests that the MEAN is likely the most practical statistic to use.

Both the PC and FR seedling tests for stool weight values were moderately correlated ($0.48 < r < 0.62$) to the clonal plot values (Table 1). The correlations seem strong enough to support the contention that family cane yield estimates based upon stool evaluation are worthy statistics for family cane yield appraisal. It appeared that the MEAN and the BLUP had somewhat stronger correlations between tests than the OBS and PROB did. It was also interesting to note that stool data collected in the PC seedlings were just as well correlated to

clonal plot data as FR seedling data. This finding may enable selection among families before selection within families occurs in early September of the first ratoon seedling stage.

The correlations among tests for stalk number were variable and poor between PC and FC ($0.04 < r < 0.46$) but moderately strong between FR and the FC tests ($0.42 < r < 0.62$) (Table 2). Correlations of PC values with the FR or FC values were better for MEAN and BLUP statistics than for OBS or PROB statistics. The statistic did not seem to matter between the FR and FC tests.

Stalk weight was rather well correlated between tests, especially between the PC and FR tests, and between the FR and FC tests (Table 3). Correlations between PC and FC were moderately strong ($0.50 < r < 0.75$).

Correlations among tests for stalk diameter were moderately strong with the exception of FC OBS and other FR statistics (Table 4). Generally, the type of statistic did not matter.

Correlations of stalk length between the PC and FR seedlings were rather strong ($0.60 < r < 0.72$) and better than between other combinations of tests (Table 5). The MEAN and the BLUP appeared to yield somewhat stronger correlations among tests than the OBS and the PROB.

Correlations between tests for Brix were all moderately strong with again slight favoring of the MEAN and the BLUP over the OBS and PROB (Table 6).

The results of this study support the use of mean stool data to predict the potential of a family to produce elite progeny. There appears little reason to use more sophisticated statistics or the need to use clonal data for family prediction. The predictions are not extremely accurate but would improve under more normal weather conditions.

Acknowledgment

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REFERENCES

Henderson, C. R. 1984. Applications of linear models in animal breeding. Univ. Guelph. ON, Canada.

Steel, R. G. D. and J. H. Torrie. 1980. Principles and procedures of statistics a biometrical approach. McGraw-Hill, Inc. New York, NY.

Table 1. Correlation of the observed elite proportion, the full-sib family mean, the predicted elite proportion and the BLUP among plant cane and first ratoon seedlings, and first clonal plots for stool weight.

	PC seedling				FR seedling				FC plots			
Test-Stat	OBS	MEAN	PROB	BLUP	OBS	MEAN	PROB	BLUP	OBS	MEAN	PROB	BLUP
PC† OBS‡	1.0	0.91	0.95	0.88	0.65	0.78	0.70	0.78	0.59	0.54	0.54	0.52
PC MEAN		1.0	0.91	0.98	0.80	0.87	0.83	0.87	0.54	0.59	0.56	0.58
PC PROB			1.0	0.89	0.57	0.70	0.64	0.69	0.55	0.51	0.49	0.53
PC BLUP				1.0	0.79	0.85	0.82	0.87	0.48	0.56	0.51	0.58
FR† OBS					1.0	0.94	0.92	0.93	0.52	0.57	0.52	0.52
FR MEAN						1.0	0.97	0.99	0.56	0.62	0.57	0.57
FR PROB							1.0	0.96	0.50	0.57	0.51	0.53
FR BLUP								1.0	0.55	0.61	0.55	0.57
FC† OBS									1.0	0.85	0.90	0.79
FC MEAN										1.0	0.97	0.98
FC PROB											1.0	0.93

† PC = plant cane seedlings; FR = first ratoon seedlings; FC = first clonal plots.
‡ OBS = observed elite proportion; MEAN = mean full-sib family value; PROB = predicted elite proportion; BLUP = best linear unbiased predictor for full-sib family.

Table 2. Correlation of the observed elite proportion, the full-sib family mean, the predicted elite proportion and the BLUP among plant cane and first ratoon seedlings, and first clonal plots for stalk number.

	PC seedling				FR seedling				FC plots			
Test-Stat	OBS	MEAN	PROB	BLUP	OBS	MEAN	PROB	BLUP	OBS	MEAN	PROB	BLUP
PC† OBS‡	1.0	0.82	0.87	0.81	0.60	0.70	0.72	0.68	0.04	0.24	0.15	0.28
PC MEAN		1.0	0.85	0.98	0.73	0.80	0.80	0.76	0.28	0.42	0.31	0.44
PC PROB			1.0	0.82	0.48	0.53	0.53	0.51	0.05	0.17	0.08	0.26
PC BLUP				1.0	0.78	0.81	0.82	0.79	0.28	0.44	0.30	0.46
FR† OBS					1.0	0.92	0.88	0.93	0.42	0.59	0.51	0.51
FR MEAN						1.0	0.99	0.99	0.52	0.66	0.58	0.56
FR PROB							1.0	0.98	0.47	0.60	0.52	0.50
FR BLUP								1.0	0.51	0.65	0.59	0.53
FC† OBS									1.0	0.70	0.86	0.53
FC MEAN										1.0	0.85	0.95
FC PROB											1.0	0.70

† PC = plant cane seedlings; FR = first ratoon seedlings; FC = first clonal plots.
‡ OBS = observed elite proportion; MEAN = mean full-sib family value; PROB = predicted elite proportion; BLUP = best linear unbiased predictor for full-sib family.

Table 3. Correlation of the observed elite proportion, the full-sib family mean, the predicted elite proportion and the BLUP among plant cane and first ratoon seedlings, and first clonal plots for stalk weight.

	PC seedling				FR seedling				FC plots			
Test-Stat	OBS	MEAN	PROB	BLUP	OBS	MEAN	PROB	BLUP	OBS	MEAN	PROB	BLUP
PC† OBS‡	1.0	0.92	0.95	0.89	0.79	0.64	0.68	0.61	0.60	0.50	0.55	0.45
PC MEAN		1.0	0.76	0.98	0.87	0.76	0.76	0.74	0.72	0.63	0.69	0.59
PC PROB			1.0	0.93	0.89	0.80	0.82	0.77	0.60	0.54	0.58	0.51
PC BLUP				1.0	0.89	0.80	0.80	0.80	0.75	0.69	0.75	0.67
FR† OBS					1.0	0.94	0.97	0.91	0.73	0.71	0.73	0.69
FR MEAN						1.0	0.98	0.98	0.60	0.65	0.66	0.65
FR PROB							1.0	0.95	0.64	0.66	0.67	0.66
FR BLUP								1.0	0.63	0.70	0.70	0.71
FC† OBS									1.0	0.92	0.95	0.91
FC MEAN										1.0	0.99	0.99
FC PROB											1.0	0.98

† PC = plant cane seedlings; FR = first ratoon seedlings; FC = first clonal plots.
‡ OBS = observed elite proportion; MEAN = mean full-sib family value; PROB = predicted elite proportion; BLUP = best linear unbiased predictor for full-sib family.

Table 4. Correlation of the observed elite proportion, the full-sib family mean, the predicted elite proportion and the BLUP among plant cane and first ratoon seedlings, and first clonal plots for stalk diameter.

	PC seedling				FR seedling				FC plots			
Test-Stat	OBS	MEAN	PROB	BLUP	OBS	MEAN	PROB	BLUP	OBS	MEAN	PROB	BLUP
PC† OBS‡	1.0	0.85	0.97	0.84	0.42	0.52	0.48	0.52	0.45	0.55	0.60	0.55
PC MEAN		1.0	0.91	0.98	0.48	0.51	0.45	0.55	0.70	0.69	0.74	0.69
PC PROB			1.0	0.91	0.59	0.64	0.62	0.65	0.57	0.68	0.72	0.68
PC BLUP				1.0	0.50	0.55	0.49	0.63	0.72	0.74	0.79	0.76
FR† OBS					1.0	0.90	0.97	0.85	0.24	0.50	0.50	0.53
FR MEAN						1.0	0.89	0.95	0.24	0.55	0.53	0.59
FR PROB							1.0	0.83	0.20	0.47	0.47	0.51
FR BLUP								1.0	0.34	0.64	0.64	0.70
FC† OBS									1.0	0.88	0.91	0.86
FC MEAN										1.0	0.97	0.99
FC PROB											1.0	0.98

† PC = plant cane seedlings; FR = first ratoon seedlings; FC = first clonal plots.
‡ OBS = observed elite proportion; MEAN = mean full-sib family value; PROB = predicted elite proportion; BLUP = best linear unbiased predictor for full-sib family.

Table 5. Correlation of the observed elite proportion, the full-sib family mean, the predicted elite proportion and the BLUP among plant cane and first ratoon seedlings, and first clonal plots for stalk length.

	PC seedling				FR seedling				FC plots			
Test-Stat	OBS	MEAN	PROB	BLUP	OBS	MEAN	PROB	BLUP	OBS	MEAN	PROB	BLUP
PC† OBS‡	1.0	0.89	0.93	0.89	0.66	0.62	0.67	0.60	0.30	0.50	0.53	0.39
PC MEAN		1.0	0.87	0.97	0.61	0.60	0.65	0.61	0.47	0.61	0.62	0.47
PC PROB			1.0	0.92	0.72	0.58	0.70	0.64	0.41	0.54	0.58	0.49
PC BLUP				1.0	0.67	0.65	0.71	0.69	0.53	0.67	0.69	0.57
FR† OBS					1.0	0.78	0.94	0.74	0.17	0.27	0.28	0.26
FR MEAN						1.0	0.86	0.94	0.31	0.50	0.49	0.50
FR PROB							1.0	0.80	0.29	0.40	0.41	0.39
FR BLUP								1.0	0.40	0.57	0.56	0.58
FC† OBS									1.0	0.95	0.94	0.94
FC MEAN										1.0	1.00	0.96
FC PROB											1.0	0.96

† PC = plant cane seedlings; FR = first ratoon seedlings; FC = first clonal plots.
‡ OBS = observed elite proportion; MEAN = mean full-sib family value; PROB = predicted elite proportion; BLUP = best linear unbiased predictor for full-sib family.

Table 6. Correlation of the observed elite proportion, the full-sib family mean, the predicted elite proportion and the BLUP among plant cane and first ratoon seedlings, and first clonal plots for Brix.

	PC seedling				FR seedling				FC plots			
Test-Stat	OBS	MEAN	PROB	BLUP	OBS	MEAN	PROB	BLUP	OBS	MEAN	PROB	BLUP
PC† OBS‡	1.0	0.95	0.96	0.91	0.38	0.44	0.44	0.40	0.59	0.61	0.63	0.54
PC MEAN		1.0	0.88	1.00	0.51	0.65	0.58	0.61	0.57	0.70	0.58	0.63
PC PROB			1.0	0.87	0.38	0.40	0.41	0.37	0.61	0.55	0.59	0.47
PC BLUP				1.0	0.50	0.65	0.58	0.62	0.54	0.70	0.57	0.63
FR† OBS					1.0	0.85	0.98	0.82	0.56	0.53	0.52	0.52
FR MEAN						1.0	0.87	0.99	0.56	0.72	0.57	0.69
FR PROB							1.0	0.86	0.56	0.58	0.54	0.57
FR BLUP								1.0	0.50	0.70	0.54	0.68
FC† OBS									1.0	0.83	0.96	0.83
FC MEAN										1.0	0.91	0.99
FC PROB											1.0	0.91

† PC = plant cane seedlings; FR = first ratoon seedlings; FC = first clonal plots.
‡ OBS = observed elite proportion; MEAN = mean full-sib family value; PROB = predicted elite proportion; BLUP = best linear unbiased predictor for full-sib family.

Table 7. Mean squares based upon full-sib family standard deviations for plant cane and first ratoon seedlings, and plant cane first clonal plots.

Source	df	Stool or plot wt.	Stalk no.	Stalk wt.	Stalk diam.	Stalk length	Brix
		$(g \times 10^{-3})^2$	$(stool^{-1})^2$	$(kg \times 10^{-3})^2$	$(cm \times 10^{-3})^2$	$(m \times 10^{-2})^2$	$\%^2$
			Plant cane seedlings				
Block	2	4.62	3.39	1.44	6.58	5.85	10.32
Spacing	1	2.18*	0.30	4.56	4.58	21.87§	1.29
Cross	14	1.74**	1.20§	9.38**	9.37§	11.01§	5.67§
Cross x spacing	14	0.70	0.51	5.61	6.64	9.96§	2.09
Error	58	0.54	0.70	3.77	5.53	5.91	3.22
			First ratoon seedlings				
Block	2	4.44	0.71	12.25	1.93	1.53	2.97
Spacing	1	19.62§	9.92	1.80	2.22	0.01	0.38
Cross	14	13.87*	13.15§	16.79**	10.71	4.57	3.02
Cross x spacing	14	5.38	5.02	5.58	10.31	7.59	4.15
Error	58	6.86	7.45	5.25	6.64	4.90	3.86
			First clonal plots				
Block	2	25.95	11.50	1.49	2.60	9.44	1.09
Cross	14	139.24	5.01	12.72	7.87	8.16	8.11**
Error	58	153.38	4.50	15.44	6.34	11.72	2.46

* $P < 0.05$; ** $P < 0.01$; § $P < 0.10$.

SUGARCANE POLLEN VIABILITY AND SEED SETTING AS AFFECTED BY DAYLENGTH DECLINE RATES AND RELATIVE HUMIDITY

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Abstract

The effects of daylength decline rates and relative humidity levels and durations on pollen viability and seed setting of sugarcane (Saccharum spp.) were investigated. Two studies were carried out at St. Gabriel Research Station of the Louisiana Agricultural Experiment Station.

Daylength decline rates of one half and one minute per day were studied on 354 crosses made within three years using 54 males and 92 females. Males treated with one half minute daylength decline rate had higher pollen viability. Seed production was not affected by the treatments. Varietal differences were found responsible for most of the variation obtained. The two rates investigated in this study can be used in the breeding program without negative effects on seed production from the crosses.

Three relative humidity levels (90%, 70%, and an ambient treatment) and three relative humidity durations during crossing (day, night, and an ambient treatment) were investigated in two experiments for their effects on pollen grain viability and seed setting of sugarcane during three seasons. Pollen viability and seed production were not affected by altering humidity level or duration. Setting the relative humidity within a range of 65 to 81% will not adversely affect pollen viability or seed production in sugarcane crosses.

Assessment of Varietal Resistance to the Sugarcane Borer

T. E. Reagan and Harry Schexnayder, Jr.

Portion of Annual Report LAES Project LA2657 and LA2013

Resistance to Diatraea saccharalis (F) damage in sugarcane can be categorized predominately as antibiosis. Physical characteristics of the plant, such as leaf-sheath appression and rapid rind hardness development contribute to the differential survival of young larvae among cultivars. The use of percent bored internodes ranks sugarcane cultivars on observed external evidence of D. saccharalis tunneling into the stalk. However, the degree of internal damage to the plant and the ultimate survival of D. saccharalis larvae are not addressed with this assessment. Varietal resistance to the latter stages of the D. saccharalis life cycle have also been investigated. Although advancement of cultivars that are less likely to be damaged by D. saccharalis should be a primary goal of the breeding program, resistance that reduces overall pest populations on an area-wide basis is also incorporated as a major entomological objective in the breeding program.

The L and LCP88 series (13 cultivars) were planted in a four-replicated lattice design on the Lanaux Plantation, at Killona, LA. Four commercial (standard) varieties were included in this study, CP70-321, CP65-357, CP76-331, and CP74-383, which respectively corresponded to SCB resistant, moderately resistant, and two susceptible varieties. At harvest, a 15 stalk sample was evaluated from each 10 foot plot for damage (% bored internodes) and relative survival in the stalk (ratio of exit holes to bored internodes).

Sugarcane borer varietal resistance evaluation revealed that four cultivars exhibited equal injury to that sustained by the resistant CP70-321 (Table 1). Although LCP88–079 resists penetration of D. saccharalis into the stalk, upon entry the larvae appear to survive better than in the other cultivars used in this study. A major complicating factor in this particular study for this year was the abnormally low seasonal borer population due to the harsh 1989-90 Winter.

Thus, our traditional resistance rating based on external evidence of D. saccharalis entry into the stalk does not accurately represent the degree of resistance acting upon larvae in the stalk.

Relative to this insect pest in sugarcane, a grower's primary objective is to minimize economic impact. There are two approaches to reduce the economic impact of pests. The first is to minimize damage caused by the pest and the second approach is to minimize the overall cost incurred controlling the pest. Use of resistant sugarcane cultivars reduces pest damage at little or no cost to the grower. D. saccharalis resistance rating schemes were focused traditionally on the prevention of damage, whereas our research now provides an additional criteria. Incorporating the cultivars' pest survival rating allows us to flag varieties which enhance D. saccharalis populations and involves little additional data collection; and enhances the efficiency and value of the entomological component in the sugarcane varietal breeding and development program of the Louisiana Agricultural Center.

Table 1. Diatraea saccharalis damage and relative survival inside the stalk in four commercial and 13 experimental cultivars (1988 series) during 1990 on the Lannaux Plantation, Killona, LA.

Variety	% Bored internodes	Relative survival	Moth production	Rating
CP70-321	6.54	0.125	7500	3
CP65-357	12.41	0.151	15000	5
CP74-383	13.71	0.183	19500	7
CP76-331	10.73	0.119	10500	7
L88-028	7.92	0.133	10000	4
L88-030	7.11	0.088	5000	3
L88-046	4.12	0.176	6000	3
L88-049	8.70	0.075	7000	4
L88-063	5.71	0.145	8000	4
L88-066	5.44	0.026	1320	3
L88-069	6.96	0.185	12000	4
L88-070	11.65	0.183	19000	7
L88-073	11.43	0.135	13000	6
L88-075	7.68	0.127	8000	4
LCP88-078	12.99	0.062	6640	5
LCP88-079	2.94	0.296	8000	3
LCP88-091	8.73	0.262	22000	6

YIELD LOSS ASSESSMENT WITH YELLOW SUGARCANE APHIDS

T. E. Reagan and Andy White

Portion of Annual Report LAES Project LA2013

During 1990, a small plot study was conducted at two locations (4 acres each) to investigate the yield loss relationships among densities of the yellow sugarcane aphid, Sipha flava (Forbes), at three stages of crop development. For experimentation, aphid infestations were built up using frequent applications of Asana (fenvalerate) or Sevin (carbaryl), and controlled as needed with Orthene (acephate) using back pack sprayers in accordance with the following treatment regimes:

Treatments (5 replications at each location)
A-With aphids early, middle, and late season
B-With aphids early and middle, but without during late
C-With aphids early, but without during mid- and late-season
D-With aphids mid- and late, but without during early season
E-With aphids middle, but without during early and late
F-With aphids early and late, but without during middle
G-With aphids late, but without during early and middle
H-Without aphids, early, mid- and late-season
I-Untreated check (no insecticides applied)

At one of two on-farm test locations (Westfield), aphid infestations were considered adequate for assessment of yield relationships. As shown in the Table 1 summary, 3-fold differences (between aphid build-up and aphid suppression) were observed in early-season (until July 15), and 10-fold differences existed mid-season (July 16-August 30) at the Paincourtville location.

Table 1. Mean number of aphids per leaf per week at the Westfield Plantation threshold study in Paincourtville, LA (Average of 10 replications per week throughout each respective crop development stage - plant cane CP65-357).

Early-Season Aphids		Mid-Season Aphids		Late-Season Aphids	
With	Without	With	Without	With	Without
5.73	1.92	30.85	3.06	0.28	.024
	(3X)		(10X)		

Because adequate late-season infestations did not occur, the experimental design set up allowed for the effect of 10 replications of comparison involving the check versus early-season and/or mid-season aphid infestations.

Data in Table 2, from the resultant infestations in Table 1, show respective early-, mid- and early + mid-season sugar losses at harvest to be 501, 630, and 707 lbs. of sugar. Based on a US price of sugar at $ .22/lb., these economic losses to the sugar producer were $100, $138, and $155 per acre, respectively. Insecticide enhancement of sugar yields in the absence of aphids was not observed. This study is intended to be repeated another year, with the expectation of getting an additional assessment of the impact of aphid infestations at all three crop developmental stages.

Table 2. Yield (lb./acre) and economics ($) of sugar in yellow sugarcane aphid economic threshold study at Westfield Plantation, Paincourtville, LA - 10 replications. (1 year of data)

Early Season Infestations	Mid-Season Infestations	Early + Mid-Season Infstn.	Aphid Control
8955	8827	8749	9456
	---Yield Loss (lbs/acre)---		
501	630	707	
	---$ Loss Per Acre---		
110	138	155	

SMUT, PYTHIUM ROOT ROT, AND SEED PIECE ROT RESEARCH

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Smut Research:

Experimental sugarcane varieties were dip-inoculated with smut spores, planted in a replicated test, and evaluated for smut resistance. During 1990, 10 (83%), 2 (17%) and none of 12 1982-1985 series; 14 (78%), 3 (17), and 1 (5%) of 18 1986 series; 22 (65%), 6 (18%), and 6 (18%) of 34 1987 series; and 21 (84%), 4 (16%), and none of 25 1988 series clones were rated as resistant, moderately susceptible, or highly susceptible, respectively.

Research on smut spore longevity in soil was completed during 1990. Results were generally similar for experiments conducted with different spore collections, in different sugarcane and nonsugarcane soils, under sterile and nonsterile conditions, and at different moisture levels. Smut spores lost viability within two months. The results indicate that spores produced during one season will not persist until the next season. The absence of inoculum during the Spring tillering season represents another factor limiting the increase of sugarcane smut in Louisiana.

Pythium Root Rot Research:

Experiments were conducted in the greenhouse to determine if additional Pythium spp. isolated from sugarcane roots are pathogenic and whether they affect the severity of root rot caused by the pathogenic species, P. arrhenomanes. Isolates of P. catenulatum and two unidentified Pythium spp. did not cause growth reductions in inoculated plants, and they did not reduce the amount of root rot caused by P. arrhenomanes. In addition, preliminary results suggested that the prokaryotic microflora occurring in one field soil did not reduce the severity of Pythium root rot.

Two experiments were conducted on commercial farms to determine if the fungicide Ridomil will control Pythium root rot and increase stubble crop yields. Ridomil was applied with fertilizer during April. The results were erratic (Table 1). Yield of pounds of sugar per acre was higher in Ridomil treated plots in one test but lower in treated plots in the other field. The reasons for the continued erratic responses to Ridomil treatment are not clear. A limitation has been the inability to detect, measure, and compare pathogen population levels.

Antisera were prepared against different Pythium species, and serological relationships were studied among nine species using a crossed immunoelectrophoresis technique. The results suggested that there are species specific antigens present in P. arrhenomanes, and it may be possible to develop a sensitive serological assay specific for P. arrhenomanes.

Transcribed ribosomal DNA was compared in five Pythium species. Pythium arrhenomanes could be distinguished from the two most common nonpathogenic Pythium species, P. irregulare and P. spinosum, based on restriction fragment length polymorphisms.

Seed Piece Rot Research:

Seed piece rot resistance testing and evaluation methods were developed during 1990. A testing method was developed in which conditions favorable for disease were established and stalks could be maintained long enough for disease levels to occur that would allow differing levels of resistance and susceptibility to be detected. Different disease symptoms were measured and compared to evaluate resistance. Preliminary results suggested that there is an interaction between resistance and the occurrence of stress.

The resistance levels of commercial varieties to three seed piece rot pathogens were determined. The results are presented in Table 2. These are preliminary results that need to be repeated. A range in resistance levels to red rot was detected in the 1984-1989 series experimental varieties. Results of the testing of a portion of the 1984-1988 series experimental varieties are shown in Table 3. The occurrence of a range in resistance levels indicates that a study of the heritability of resistance can be conducted.

Table 1. Yields from commercial farm tests in which Ridomil was applied with fertilizer to first stubble of CP 79-318.

Test	Stalks/plot		Stalk wt.[a]		Cane/acre[b]		Sugar/acre[a]		Sugar/ton[a]	
	+	-	+	-	+	-	+	-	+	-
1										
Mean	1266	1336*	2.21*	2.06	33.7	33.1	7306	7433	217	225*
Difference		+70	+0.15		+0.6			+127		+8
2										
Mean	1097	1067	2.39	2.35	31.5	30.1	6981	6724	221	223
Difference	+33		+0.04		+1.4		+257			

aYield in pounds.
bYield in tons.

Table 2. Preliminary stalk rot resistance ratings for sugarcane varieties determined in inoculated tests conducted during 1990.

Variety	Resistance ratings for three diseases[a]		
	Red rot	Fusarium sett rot	Phytophthora seed piece rot
CP 65-357	6.5	8.0	2.0
CP 70-321	6.5	5.0	2.0
CP 72-370	4.2	4.0	2.0
CP 73-351	2.8	3.0	-
CP 74-383	5.0	2.0	2.0
LCP 82-89	4.2	-	2.0

aRatings are assigned using a 2,5,8 scale where 2 = resistant, 5 = intermediate, and 8 = susceptible.

Table 3. Red rot symptoms and preliminary ratings of 1984-1988 series experimental varieties determined from stalk inoculation test conducted during 1990.

Variety	Avg. no. nodes passed	Avg. no. rotted internode	Percent node discoloration	Avg. no. nodes rotted	Resistance rating[a]
CP 84-730	3.2	3.3	77	2.5	8
LCP 85-376	3.0	3.0	89	2.7	6.5
LCP 85-384	2.2	2.3	75	1.6	5
LCP 86-408	1.2	1.2	50	0.6	2
LCP 86-420	2.3	2.1	57	1.3	5
LCP 87-23	3.7	3.0	86	3.2	8
LCP 87-472	2.2	1.9	92	2.0	3.5
LCP 87-491	2.5	2.2	93	2.3	5
LCP 87-494	2.7	2.2	81	2.2	5
L 88-46	4.2	4.1	71	3.0	8
L 88-49	2.8	1.4	100	2.8	3.5
L 88-73	5.6	3.3	83	4.6	8
L 88-75	2.6	2.0	92	2.4	5
LCP 88-78	3.0	3.3	100	3.0	8
LCP 88-91	3.2	2.0	100	3.2	6.5

aResistance ratings assigned using a 2,5,8 scale where 2 = resistant
5 = intermediate, and 8 = susceptible.

SUGARCANE PATHOLOGY RESEARCH

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During 1990 a manuscript entitled "Distribution and incidence of ratoon stunting disease in Louisiana sugarcane" was accepted for publication in the journal Plant Disease. It establishes four important findings which need to be addressed if this disease is to be managed.

First, it points out that RSD was distributed in the selection program prior to release. At the time of release some growers in the western area received substantially diseased cane.

Second, the incidence of RSD by cultivar in prospective seed sources from growers own fields was determined. The average across all cultivars was 22% RSD positive. In addition growers from the western region where diseased seed cane was released had substantially higher disease incidence in fields of that cultivar than did growers from the eastern area where clean seed was released. This was the first time any sugarcane industry had established the endemic levels of disease present by cultivar in their sources. This information is essential to help determine thresholds or acceptable levels of disease in seed sources.

A third piece of information bearing on thresholds or acceptable disease levels in seed sources was forthcoming from this work. When disease incidence levels across all cultivars were regressed against years after heat treatment, a straight line with approximately a 10% increase per year after the first year was found. This resulted in approximately a 40% incidence by the fifth year after heat treatment. This was explained by the spread of the disease by the mechanical harvester back into and through the cane at each subsequent harvest.

The fourth conclusion from this work was that 22% disease incidence in standing cane which was found in prospective seed sources should be increased by 10% due to the projected RSD spread when the cane was harvested for replanting. Therefore, the best estimate is that approximately one-third of the seed cane planted in Louisiana has RSD.

During 1990, a four year study was completed which addressed the rate of harvester spread of RSD using cultivars of varying susceptibility. The results conclusively showed that the rate of spread was different for each cultivar studied and a function of the cultivar's susceptibility. This means that resistant low spread cultivars can tolerate higher threshold levels of RSD than susceptible high spread cultivars. This also reinforces the need to breed for resistance to this disease not only for the inherent resistance but also for the effect on limiting spread. These results were presented in the fall of 1990 at our national meeting (Damann, K. E. 1990. Effect of sugarcane cultivar susceptibility on the rate of spread of ratoon stunting disease by the mechanical harvester. Phytopathology 80:1001) and a manuscript is in preparation. This mechanical

harvester RSD spread work is being continued in cooperation with Jeff Flynn of CGI using spring plantings of Kleen-Tek cultivars at St. Gabriel.

During 1990, I initiated a change in research emphasis toward tissue culture approaches to improving disease resistance in sugarcane. Tissue cultures of appropriate cultivars were established, protoplasts generated and plasmids accumulated which will be used for transformation. Tests on effects of Dr. Jesse Jaynes' lytic peptides on sugarcane smut were conducted. Several lytic peptides were shown to be effective in inhibiting the pathogen. Efforts to biolistically transform two agronomically superior cultivars (CP 73-351 and LCP 82-47) with the gene for lytic peptide will be undertaken in attempts to confer smut resistance to these cultivars and resurrect them for agricultural use.

SUGARCANE ANALYSIS USING NEAR INFRARED SPECTROSCOPY

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Introduction:

Sugar, fiber and moisture contents are essential measurements for determining sugarcane quality in the sugarcane industry. The traditional press-method (Tanimoto,1964), however requires 4-5 hours to complete and is very labor intensive. An alternate method requiring considerably less time would be very helpful.

The application of NIR is becoming increasingly popular in the food and agricultural industry. It is for example used for protein, fat and moisture determination. Sverzut et al. (1987), and Berding et al. (1989) examined the application of NIR spectroscopy to the analysis of sugarcane but neither study provides a basis for its adoption in the sugar industry.

Vaccari and Mantovani (1989) concluded that NIR methods have been found to be of benefit for moisture and pol analysis but that results concerning reducing sugars and ash in molasses are not sufficiently reliable.

NIR spectroscopy is an inferential analytical technique. NIR instruments determine components by measuring log (1/R) values where R is the reflectance. These values must then be related to the amount of the component as determined by some other method called a standard or a reference method. The relationship between the log (1/R) values and the standard method values is expressed as a regression equation.

The first step is to establish a calibration for each constituent to be measured with at least 50 samples. This calibration is subsequently used to validate with different samples to evaluate the accuracy of prediction of the calibration. The goal of a calibration is to identify a minimum number of wavelengths that gives the highest correlation and the lowest error, as compared to the standard techniques.

Urlings (1989) performed reasonable calibrations with shredded unpressed sugarcane for research purposes. The sugarcane he used was without any contamination and all the experiments were performed in a lab situation. The question is if NIR spectroscopy can be utilized in the sugarcane industry where usually highly contaminated cane is involved.

The objectives of this study were:

1. To develop and evaluate a calibration to determine brix, pol, moisture content, fiber, sucrose and sediment in contaminated sugarcane core samples with a ten fixed filter wavelength spectroscope as compared to the standard press method.

2. To use NIR spectroscopy for the determination of brix, reducing sugars, ash and true sucrose in cane-molasses.

NIR Analysis:

The press method of Tanimoto (1964) was used to determine brix, pol, moisture content, fiber, sucrose and sediment in sugarcane samples. The standard method of molasses analysis consist of the following elements: Measuring brix with a refractometer, reducing sugars with a high pressure liquid chromatograph, and ash content by conductivity. The NIR method required the values from the standard method to calibrate the Dickey John Instalab 600 NIR spectroscope[1] and to compare the developed calibrations with the standard method results.

In this study three experiments with sugarcane and one with molasses were conducted. The sugarcane samples were obtained from the St. Gabriel Research Station of Louisiana Agricultural Experiment Station, the Cinclare sugarmill and the St. Mary sugarmill. The molasses samples were acquired from the Audubon Sugar Institute. All the sugarcane experiments were conducted with shredded unpressed sugarcane.

There was a noticeable difference in particle size of the sugarcane samples from the St. Gabriel Research Station and the two sugarmills. This was due to the two different shredders that were used. In St. Gabriel each sample was shredded with a Jeffco food and fodder cutter grinder knife mill, model 265, size 10 which produced samples of a very uniform particle size. In both sugarmills a J&L/Honiron pre-breaker was used which resulted in a very heterogenous particle size.

The objective of the first experiment was to investigate the possibility of creating one calibration for each constituent for five major commercial sugarcane varieties. This is only possible if the calibrations are not variety sensitive. To prove this, two sample sets were taken for comparison. The first set contained samples of one variety and the second set contained five different commercial varieties. All the samples of the first experiment were obtained from the St. Gabriel Research Station.

In the first data set 35 samples of variety CP 79-318 were used for the calibration. Whole stalks were shredded and analyzed by the standard press method. The NIR measurements were performed on the same day as the standard press method to minimize the differences due to degradation of the samples.

The calibration for the several constituents in this data set did not give good results. In the second data set, 40 samples of 5 commercial varieties (CP 70-321, 65-357, 76-331, 72-370, 74-383) were taken. To get a wider range of the different constituents than the first data set, 40

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[1] Trade names are used in this paper solely to provide specific information. Mention of a trade name does not constitute a warranty of the product by the Louisiana Agricultural Experiment Station of the LSU Agricultural Center nor an endorsement of the product to the exclusion of other products not mentioned.

samples were obtained by cutting six stalks of each variety into top and bottom halves, as the sugar content in the bottom half is higher than in the top half. Two samples of each top and bottom half of 3 stalks for each variety were taken.

After making these calibrations for the different constituents they were tested by taking a validation set of 35 samples. Because of a shortage of samples the first data set was used as a validation set. The statistical analysis for this validation included the standard error of prediction (SEP) and the correlation coefficient (R^2) between the NIR values and the standard method results.

After good calibrations with the ' clean and well shredded' sugarcane were derived, the second experiment was to make a calibration with the contaminated core samples in the Cinclare sugarmill. Sixty core samples were analyzed with the Dickey-John spectroscope at the same time as the standard press method was conducted. The calibrations were not validated because of poor calibration.

To investigate whether the poor calibration results were due to the contamination or the heterogenous particle size, a third experiment was conducted. After 80 core samples were passed through the pre-breaker, they were shredded with a food processor. Also 66 core samples were blended using a household blender. Good calibrations were not found for any of the constituents. Since neither the food processor nor the household-blender gave uniform particle sizes, 60 core samples of the St. Mary sugar mill were taken to St. Gabriel to be shredded. Even after shredding with the Jeffco food and fodder cutter grinder, good calibrations did not result.

The last experiment with molasses, was performed in Audubon Sugar Institute. Sixty samples of final molasses were taken from 17 different sugarmills in order to get a good calibration of the Dickey-John for the constituents brix, reducing sugars, ash and true sucrose.

Results:

The best calibration equations using the Dickey-John 600 Instalab were derived by using the second data set of the first experiment. Clean sugarcane shredded with the Jeffco food and fodder cutter grinder was used in this experiment. The wavelengths selected, the regression constants, the multiple correlation coefficients and the standard errors are shown in Table 1.

The correlation coefficients and the standard error of prediction were determined for the validation set of 35 samples. The results of these calculations are shown in Table 2.

The multiple correlation coefficients of the first data set ranged from 0.7022 for sucrose to 0.7734 for moisture. The reason that the multiple correlation coefficients of the first set are lower than the second set is probably due to the range of measurements. The constituents of the second set were measured in a wider range (top and bottom analysis) than the first set.

No good calibration equations were found with the contaminated core samples of the Cinclare Sugarmill and the St. Mary Sugarmill. Refining the core samples with a food processor or a household blender did not give better calibration results. Even after refining the core samples

with the Jeffco food and fodder cutter grinder no better calibration results were received.

One good calibration equation for brix was found for the molasses experiment. The multiple correlation coefficient between the NIR data and the lab analysis was 0.8968 which is quite promising. The standard error was 0.8332. The calibration for brix gave a R^2 of 0.870 and a SEP of 0.745 in the validation.

Summary and Recommendations:

NIR spectroscopy was used to determine brix, pol, moisture content, fiber, sucrose and sediment in shredded unpressed sugarcane samples. Clean and well shredded samples of different commercial varieties showed a very high correlation between the press method and the NIR method (Table 1). Also the validation, which contained different varieties than the calibration samples, showed reasonable results (Table 2). These calibration equations can not be used in the industry because contaminated heterogenous cane is used.

The applications of NIR spectroscopy in the industry turned out to be worse than in research. No good calibrations were derived. The particle size of the core samples was refined but this did not affect the calibration results. Probably the contamination does influence the radiation which is reflected from the sample. More research on this part is necessary.

The molasses study resulted in one good calibration for brix with a multiple correlation coefficient of 0.8968 and a standard error of 0.8332. This is due to the fact that the wavelengths used were for sugarcane. To improve the calibration and the validation of the constituents reducing sugars, ash and true sucrose, other wavelengths should be investigated.

References

Berding, N., G.A. Brotherton, D.G. LeBrock, J.C. Skinner. 1989. Application of NIR spectroscopy to the analysis of sugar cane in clonal evaluation trials. Proceedings of the Australian Society of Sugarcane Technologists:124-127

Sverzut, C.B., L.R. Verma, A.D. French. 1987. Sugarcane analysis using Near Infrared Spectroscopy. Transactions of the ASAE 30(1):225-258.

Tanimoto, T. 1964. The press method of cane analysis. The Hawaiian Planters Record 57(2):133-150.

Vaccari, G.,G. Matovani.1989. Use of Near-Infrared Spectroscopy in raw cane sugar moisture analysis. Zuckerind. 114(1):75-78.

Urlings, P.M., L.R. Verma, D.E. Martin. 1989. Sugarcane analysis using Near Infrared Spectroscopy. Annual Progress Report of the Louisiana agricultural experiment station.197-201.

GLUCOSE-FRUCTOSE EQUILIBRIA ON DOWEX MONOSPHERE 99 CA RESIN* UNDER OVERLOADED CONDITIONS

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INTRODUCTION

The continuous simulated moving bed (SMB) fructose-selective adsorptive separation of 42 % glucose-fructose mixtures has been a standard process in the HFCS (high fructose corn syrup) production for a decade. In the last two years, using the potassium form of the sulphonated polystyrene resins, the technology was applied on an industrial scale for the desugarization of sugarbeet molasses (ion-exclusion) and, pending resolution of problems with pre-treatment of the more impure sugarcane solutions, it promises new possibilities in the sugarcane industry as well.

For reliable modeling and design of a large scale SMB operation it is crucial to understand the properties of the adsorbent, viz. adsorption equilibria (partition coefficients) and mass transfer rates. These should be determined preferably by pulse testing [1]

on the SMB system itself or a scalable pilot to account correctly not only for the properties of the adsorbent but also for the band broadening from column connections and valves and column packing characteristics. Care should be taken that the loading, flow rates and the range of concentrations in the tests be comparable to the conditions prevaling in the SMB process. It was shown recently [2] that the frequently made assumption of linear and uncoupled isotherms of glucose and fructose on Ca^{++} polystyrene resins may not be valid at high concentrations (see Table I) and that it effects considerably the predicted steady state profile within an SMB system. This in turn leads to operational parameters (switching time and flow rates) that, if based on the model, result in less than optimum separation.

In this communication we report on our results of measuring the adsorptive properties of a DOWEX Monosphere 99 CA resin (Ca^{++} form)

*DOWEX Monosphere is a registered trademark of the DOW Chemical Co., Midland, MI, USA

for glucose and fructose under conditions of high concentrations. The obtained isotherms are used to model the SMB separation of glucose - fructose mixtures.

PROCEDURES

The SMB pilot at Audubon Sugar Institute consists of eight identical jacketed glass columns (210 cm x 6 cm id, column volume 5,940 ml) connected with a series of either computer- or manually operated solenoid valves and sampling ports. The pulse tests were done on either 6 or 7 in-series connected columns, packed with

Table I: Partition coefficient of glucose (K_G) and fructose (K_F) on several sulphonated polystyrene resins in Ca^{++} form.

$K_G = K_{G0} + A_1c_G + B_1c_F$
$K_F = K_{F0} + A_2c_G + B_2c_F$

Sorbent	Reference	T °C	K_{G0}	A_1	B_1	K_{F0}	A_2	B_2	K_{F0}/K_{G0}
DOWEX 50W-X8	Ghim and Chang, 1982	30	.30	0	0	.80	0	0	2.7
Zerolit 225 SRC 14	Ching and Ruthven, 1984	20	.20	0	0	.78	0	0	3.9
		30	.20	0	0	.67	0	0	3.4
		48	.20	0	0	.56	0	0	2.8
		60	.20	0	0	.49	0	0	2.5
Duolite C204	Ching and Ruthven, 1986	29	.5	0	0	.88	0	0	1.8
		52.5	.5	0	0	.75	0	0	1.5
		70	.5	0	0	.67	0	0	1.3
Korela V07C	Barker and Ganetsos, 1985		.215	0	0	.472	0	0	2.2
Duolite C204	Ching and Ruthven, 1985	25	.51	0	0	.88	0	0	1.7
Zerolit SRC14	Barker and Thawait, 1986 Ruthven, 1986	25	.126	.0039	.0024	.38	.0065	.00075	3.0
Duolite C204	Ching etal., 1987	55	.36	.001	.0015	.465	.0015	.0025	1.3
Duolite C204F	Viard and Lameloise, 1989	60	.374	0	0	.468	0	0	1.3
DOWEX Monosphere 99 CA	This work	70	.245	.0051	.003	.47	.007	.0049	1.9

Note: a "0" indicates that this parameter was not determined (a linear model was assumed a priori) rather than that it was determined to be zero

DOWEX Monosphere 99 CA resin (particle size 0.32 mm, 6 % cross-link) and kept at 70 °C, by first feeding the top of the first

Table 1. Calibration results in unpressed shredded sugarcane using clean unpressed shredded sugarcane.

Constituent	regression constants	Wavelength	Multiple correlation	Standard Error
Brix	K(a)= -18.506 K(7)= -0.516 K(8)= 0.118 K(9)= 0.440	 1875 2208 2270	0.9571	0.463
Pol	K(a)=-167.071 K(1)= -0.388 K(7)= -2.508 K(9)= 3.171	 1465 1875 2270	0.9557	2.721
Moisture percentage cane	K(a)= 110.789 K(7)= 0.556 K(8)= -0.126 K(9)= -0.474	 1875 2208 2270	0.9392	0.601
Fiber	K(a)= 16.208 K(3)= -0.657 K(4)= 0.937 K(6)= -0.291	 1680 1734 1840	0.7977	0.313
Sucrose	K(a)= -37.562 K(1)= -0.089 K(7)= -0.571 K(9)= 0.725	 1465 1875 2270	0.9539	0.634

Table 2. Validation of the Calibration.

Constituent	R^2	SEP
Brix	0.706	0.711
Pol	0.661	4.328
Moisture % cane	0.683	0.878
Fiber	0.733	0.447
sucrose	0.657	0.991

column with about 300 g of fructose/glucose solutions of various compositions and then eluting the components with hot de-ionized water at flow rates between 120 and 160 ml/min. The direction of the flow was down in all columns to eliminate problems with fluidizing the resin bed [7]. The elution time was measured from the moment of switching the water pump on. The samples were then taken periodically and their concentration (refractive index) determined off-line. HPLC analysis (Bio-Rad HPX87N column) was used in case of two-component feeds. In the high load tests (e.g. runs 5, 6, 11 and 12 in Figure 2), columns number one (runs 5 and 12) and one and two in series (runs 6 and 12) were used as feed reservoirs by feeding these columns with the feed until the outlet reached the inlet composition. Then a connection was made with the rest of the columns and the feed eluted as before.

The response signals were integrated numerically to give the mean and variance of the elution peaks,

$$t' = \int ctdt / \int cdt$$

$$\sigma^2 = \int c(t-t')^2 dt / \int cdt$$

The chromatographic HETP was calculated as $L'(\sigma/t')^2$ where the total column length L was corrected for the length of the feed "plug" L_f as

$$L' = L - \tfrac{1}{2} L_f = L - \tfrac{1}{2} m_f/(\rho \epsilon A)$$

(ρ = feed density; A, the column cross-section area). In high load tests, L_f was taken as L or 2L (L = column length, 210 cm) depending on whether one or two columns were equilibrated initially with the feed. Thus, in the HFCS experiments, the load in respect to fructose was higher (by the excess in the solid phase) than would correspond to the HFCS composition.
The assumed form of the distribution coefficients was as before (Table I)

$$K_G \equiv q_G/c_G = K_{G0} + A_1 c_G + B_1 c_F$$

$$K_F \equiv q_F/c_F = K_{F0} + A_2 c_G + B_2 c_F$$

(c = liquid concentration, g/100 ml; q = concentration in resin, g/100 ml resin)
and the coefficients were obtained by matching the experimental profiles with those calculated from a local equilibrium model

$$\partial c/\partial t + ((1-\epsilon)/\epsilon)\partial q/\partial t + v(\partial c/\partial z) = 0$$

The time and space partial derivatives were replaced as usual with finite differences of the forward and backward types respectively and solved on a 386-based PC. The nonlinearities stemming from the

form of the distribution coefficients were accommodated with an internal iteration procedure. The time and length integration steps (0.8 min and 10 cm) were chosen such as to match the profiles of low concentration pulse responses (Figure 1) and thus substitute for the lack of explicit axial dispersion terms (axial mixing and mass transfer) in the master equation.
K_{G0} and K_{F0} were obtained by matching the low concentration feed profiles (single components feeds) with those calculated while neglecting the concentration dependent terms of the distribution coefficients (A1 = A2 = B1 = B2 = 0). A_1 and B_2 were obtained from single component runs with feed concentrations from 15 to 60 w % (with $A_2 = B_1 = 0$), while the cross-coefficients, A_2 and B_1 were obtained from runs where the feed was an HFCS syrup diluted to between 10 and 60 w%.
The system void fraction $\epsilon = 0.47$, that includes the column connections, valves, etc. was found from pulse tests with a high M_w dextran.

RESULTS AND DISCUSSION

The HETP evaluated from runs 1 - 4 and 7 - 10 is 2.7 (σ = 0.5, N = 4) and 3.5 cm (0.2, 4) for glucose and fructose respectively, about 1/3 of those found by Ching and Ruthven [4] on somewhat smaller columns.

The retention time (empty column bed volumes eluted at the peak maxima) generally increases (Figure 2) with the column load (proportional to the feed volume and concentration) although the volume-averaged concentrations of the bands as they move through the column should prove a more meaningful parameter in correlating the retention times.

The average values of the parameters determined here fall within the range found previously for similar resins (Table I):

$$K_G = 0.245 + 0.0051\ c_G + 0.003\ c_F$$

$$K_F = 0.47 + 0.007\ c_G + 0.0049\ c_F$$

The separation on the DOWEX Monosphere 99 CA resins judged by the K_{F0}/K_{G0} ratio, 1.92 at 70 °C, appears superior to that on the Duolite resins at the same temperature. (Table I).
The upward curvature of the isotherms causes the characteristic "sharpening" of the fructose band (Figure 3): while the tail (c_G = 0) is made steeper because $B_2 > 0$ (a low concentration element of the solutions travels faster that a high concentration one, i.e. the peak of the band) , the broadening of the front (that would be expected in a single component band) is countered by the effect of glucose, i.e. the front of the fructose band is slowed down on account of glucose, relative to the velocity of the maximum of the fructose band.

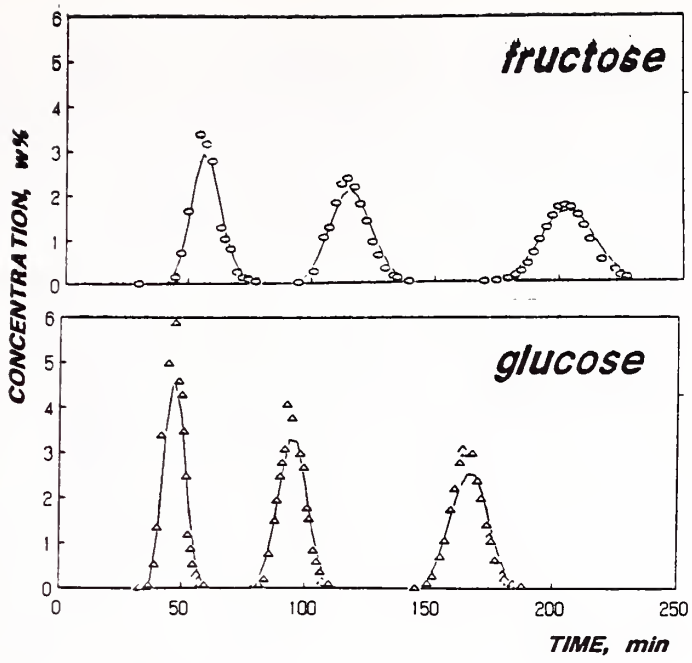

Figure 1: The experimental (circles and triangles) and calculated (solid line) elution profiles of fructose and glucose (single component feeds). A total of six in-series columns, sampled after two, four and six columns respectively. Fructose run: C_f= 19.8 %, q = 146.5 ml/min. Glucose run: C_f = 23.6 %, q = 150.2 ml/min. K_{GO} = 0.245, A_1 = 0.0051, K_{FO} = 0.47, B_2 = 0.0049.

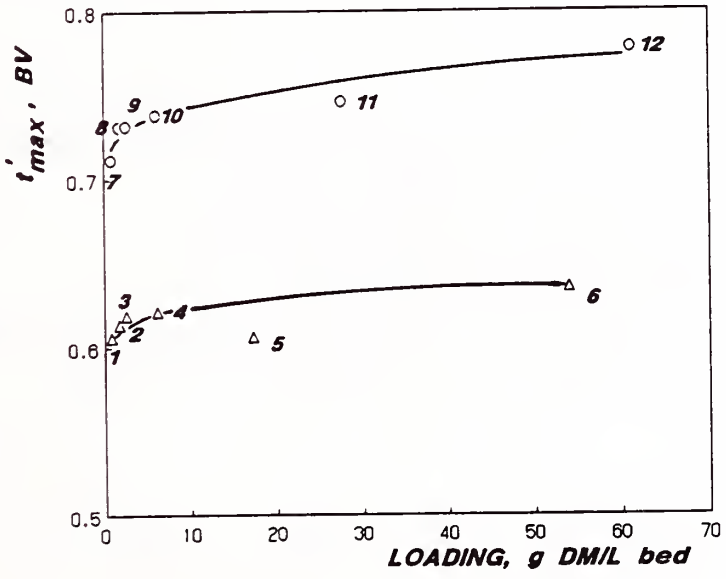

Figure 2: The retention times (t'max) in bed volumes at different column loadings. Single component feeds. The run parameters for runs 1 - 12 [run number (C_f; dry matter fed; L_f)]: 1 (11.0%; 33 g; 11), 2 (20.5 %; 62.5; 11), 3 (30.4 %; 96.7 g; 11), 4 (60.5 %; 219 g; 11), 5 (16.8 %; 668 g; 210), 6 (20 %; 1603 g; 420), 7 (10 %; 30 g; 11), 8 (20.4 %; 62.6 g; 11), 9 (29.7 %; 95.0 g; 11), 10 (59.7 %; 217.9 g; 11), 11 (20.0 %; 905 g; 210), 12 (20.0%; 1814 g; 240). bed volumes = $qt'_{max}/L'A$.

The non-linearity and dependence of the isotherms can be qualitatively understood by considering the limited accessibility of the internal surface of the resin for the sugar molecules. The volume-weighted median pore size (diameter) of the resin is about 10 A (one half of the total volume of the pores below 10 A, one half above 10 A), so that a large fraction of the pores is of a diameter roughly equal to the diameter of the hydrated sugar molecules. Penetration into these micropores then involves displacing the hydration layers of the counterions as well as, perhaps, those of the diffusing sugar molecules; a process favored by the increasing sugar concentration in the liquid as well as by the diminishing concentration of the water molecules at high sugar concentrations. The degree of hydration and the diameter of the hydrated sugar clusters are known to be less at high sugar concentrations. The contraction of the resin at high sugar concentrations (Figure 4) may be expected, though, to also at least partially contribute to the non-linearities. While the pore volume and mean pore size are likely to decrease as a result of bead contraction and thus contribute to a Langmuir-type behaviour, the bed void fraction may not be a constant as assumed in the above partial differential equation but rather an increasing function of concentration. This would then be expected to contribute to the upward curvatures of the isotherms.

As expected, the simulated steady-state SMB profiles differ significantly depending on the assumed adsorption characteristics of the components (Figure 5). If known accurately at the conditions prevaling in the SMB process, they can in turn be used to optimize the SMB separation. The simulation can be handled with a fast personal computer [11] and thus provide an accessible tool to an efficient operation.

REFERENCES

[1] A. deRosset, R. W. Neuzil and D. J. Korous, Ind. Eng. Chem.,Process Des. Dev. 15 (1976) 261.
[2] C. B. Ching, C. Ho, K. Hidajat and D. M. Ruthven, Chem. Eng. Sci. 42 (1987) 2547.
[3] Y. S. Ghim and H. N. Chang, Ind. Eng. Chem. Fundam. 21 (1982) 369.
[4] C. B. Ching and D. M. Ruthven, Can. J. Chem. Engng. 62 (1984) 398.
[5] C. B. Ching and D. M. Ruthven, Chem. Eng. Sci. 41 (1986) 3063.
[6] P. E. Barker and G. Ganetsos, J. Chem. Tech. Biotechnol. 35 (1985) 217.
[7] C. B. Ching and D. M. Ruthven, Chem. Eng. Sci. 40 (1985) 877.
[8] P. E. Barker and S. Thawait, J. Chromatog. 295 (1984) 479.
[9] V. Viard and M. L. Lameloise, ENSIA (Ecole Nationale Superieure des Industries Agricoles et Alimentaires), Massy, France.
[10] M. Mrini, MS Thesis, Louisiana State University, Baton Rouge, LA, in progress.
[11] M. Saska, unpublished.

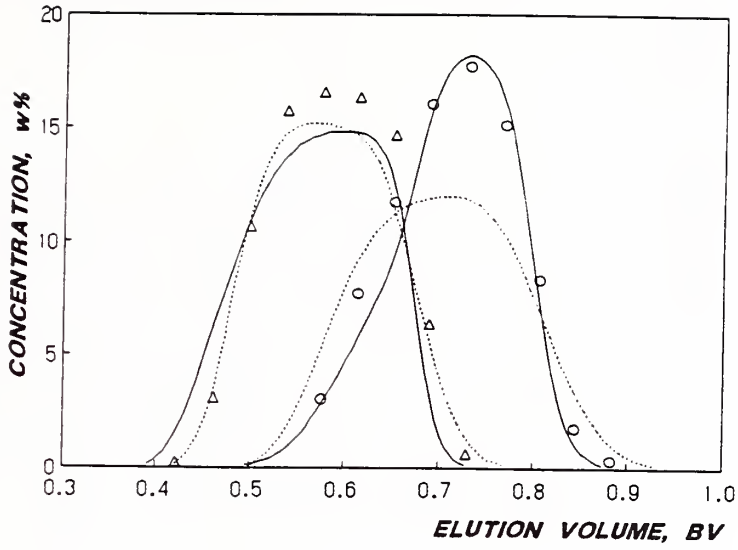

Figure 3: Measured elution profiles (triangles = glucose, circles = fructose) and those calculated from the non-linear model (solid lines): K_{G0} = 0.245, A_1 = 0.0051, B_1 = 0.001, K_{F0} = 0.47, A_2 = 0.01, B_2 = 0.0049. Dotted lines = a "best" linear model: K_{G0} = 0.35, K_{F0} = 0.60, A_1 = A_2 = B_1 = B_2 = 0. q = 135 ml/min, feed: 30 w % HFCS.

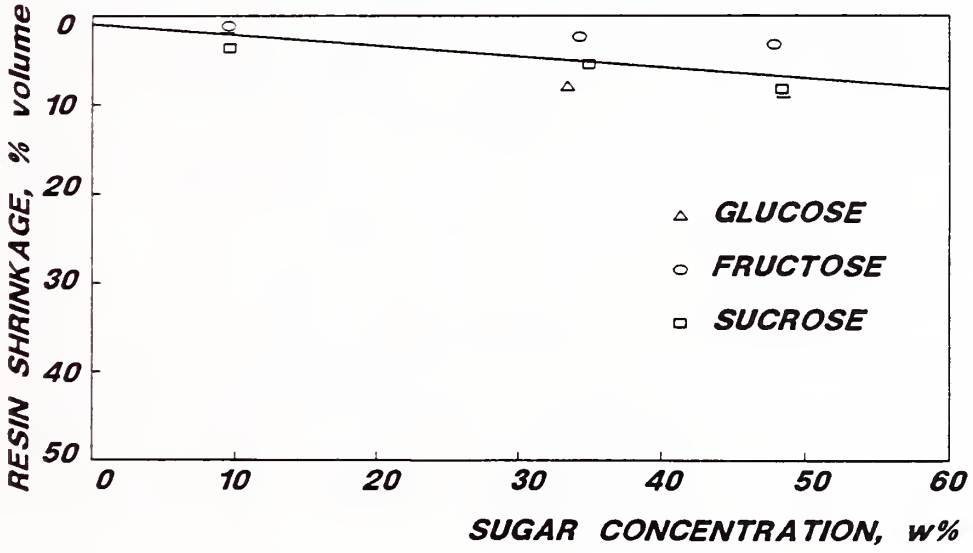

Figure 4: Shrinkage of the resin beads at various sugar concentrations. DOWEX Monosphere 99 CA resin. Determined by direct measuring of the beads diameters at high magnifications. From (Mrini, 1991).

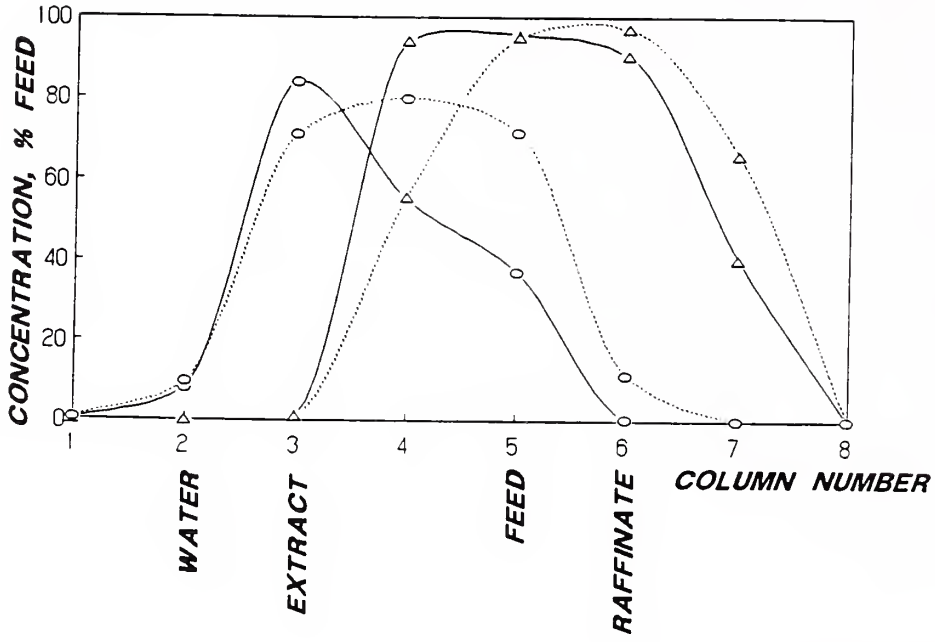

Figure 5: Simulated steady-state SMB profiles (triangles = glucose, circles = fructose) for a linear (dotted lines) and non-linear (solid lines) isotherms (parameters listed in Figure 3). Feed: 30 % HFCS. Flow rates: feed 23.3 ml/min (0.029 BV/hr), water 46.6 (0.059), extract (fructose product) 28.3 (0.036), raffinate (glucose product) 41.7 (0.053), recycle 100 (0.126). Switching time: linear 30.4 min, non-linear 28.8 min. Total bed volume 47,520 ml. System configuration: water: in column 2, extract: out of column 3, feed: in column 5, raffinate: out of column 6.

ENTRAINMENT OF DEXTRANS, Na AND K IN SUCROSE CRYSTALLIZATION

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INTRODUCTION

The two principle lines of thought on how impurities get incorporated in the growing crystalline structure, i.e. as more or less non-specific micron or so sized pockets of the mother liquor on one hand and as overgrown adsorbed layers on the other, have justification in sucrose crystallization but the question of their respective contributions to the total amount of impurities found in the product sucrose crystals has not been resolved yet to satisfaction. This is undoubtedly due to the scarcity of reliable quantitative data on incorporation of well defined impurities in sucrose crystallization as well as nearly complete lack of data on the volume or mass of the "included" mother-liquor.

This work has focused on determining the "incorporation characteristics" of dextran, a linear homopolymer of glucose (DP 20 to 70,000) and two common salts, NaCl and KCl. While all three are of importance on their own in the sugar producing and refining industries, it was further the intention to investigate whether and to what extent would the dextrans parallel the behaviour of colorants which as some evidence indicates is efected by the size of the molecule rather than its chemical character. Further, since the ionic strength of the solution may effect both the macromolecular and surface characteristics and thus the incorporation behaviour, the two salts were applied in some runs at the level characteristic for the industrial sugar solutions.

EXPERIMENTAL PROCEDURES

One large M_w dextran (Sigma Chemical, industrial grade, M_w 5,000,000 - 40,000,000, cat # D5501) and one low Mw dextran (Sigma Chemical , M_w 17,200, cat # D4626) were used in this work. These will be referred to as D1 and D3 respectively. While D1 and D3 were used as supplied by the manufaturer, in addition, a 5 % aqueous solution of D1 was sonicated following a procedure reported earlier (Saska,1990) in order to reduce its M_w; the product (used as the 5 % solution) will be referred to later as D2. The characteristics of the fractions are listed in Table I.

Table I: Characteristics of the additives and entrained fractions.

FRACTION	M_w x 10^6	Std.Dev. x 10^6	N
D1	7.00	1.38	5
D2	3.64	0.23	5
D1-product	9.88	1.63	6
D2-product	6.67	2.21	9

Note: X-product indicates the dextran fraction entrained in the product from crystallization in which X was the additive. These values are averages of the runs in which X was the additive, each M_w determined once for each sample.

Concentration of dextrans in the solution and product crystals (with the exception of the D3 containing products) was determined with an HPLC equipped with 2 in-series Waters' SEC Ultrahydrogel 250 columns, 0.1 N $NaNO_3$ as an eluent and a standard curve that had been found identical for several solutes (Figure 1) as expected for a RI detector. All other parameters are given in Figures 2 and 3. Since no other large M_w compounds were present in our synthetic solutions, the integration of the SEC chromatograms gave directly the dextran concentrations. The separation of the large M_w peaks from that of sugars and salts was complete for D1 and D2 (Figure 2). The small overlap (Figure 3) in case of D3 was not expected to introduce a significant error.
To account for the fraction of the product from the seed crystals, a correction factor, $m_p/(m_p-m_s)$, was applied
(m_p = mass of product crystals, m_s = mass of seed crystals). The corrected concentrations then represent the composition of the product grown during the experiment and those are the concentrations given in the following text.

The M_w of the source dextrans as well as those of dextrans entrained in the product crystals were determined with a SEC/MALLS system equipped with a Waters' Ultrahydrogel Linear column and a Wyatt Technology 15-angle DAWN-F multi-angle light scattering detector (MALLS) followed in series by a Waters' 410 RI detector (Jackson, Nilssen and Wyatt, 1989). The dextran concentrations in the products where D3 was used as the additive were determined with the more sensitive SEC/MALLS system using the Wyatt ASTRA integration software (Wyatt, Jackson and Wyatt, 1988) with dn/dC of dextran (the concentration derivative of the refractive index) of 0.142 ml/g from the literature (Vink and Dahlstrom, 1967). The two methods (Figure 4) correlated well although the SEC/MALLS, though more sensitive, gave somewhat lower results. The D3

concentrations in the product crystals were then obtained from the correlation X = (Y + 18.8)/0.78, where X, Y and the constants are defined in Figure 4. The samples of the crystallizing solutions for dextran analysis were taken at the start and end of each run and the average values are used in the following. Throughout this text the dextran concentrations are in units of ppm of total dissolved solids, equivalent to 10^{-4} x w% (dry basis).

The crystallization was done in a 250 ml stirred (300 min^{-1}) fluidized bed glass reactor (Figure 5) described previously in connection with the crystallization work with synthetic and natural colorants as additives (Schliephake, 1989). The crystallizer, seeded with 10 g of 0.64 mm pure sucrose crystals and kept at 70 C was fed with solutions of supersaturations between 0.01 and 0.12. The crystals were grown until reaching at least twice the initial size, then they were separated with a laboratory centrifuge and washed twice with a sucrose-saturated aqueous solution and then twice with pure propylalcohol. The size of the product crystals, d_p was estimated in two ways (Figure 6): from microphotographs where the circumference of the particles was measured manually with a Kontron magnetostriction planimeter (Austmeyer, 1980) and from the mass, m_p of the product as

$$d_p = d_s \, (m_p/m_s)^{1/3} \qquad (1)$$

where d_s and m_s are the seed crystal size (0.64 mm) and mass (10 g) respectively. Although both methods rely on the assumption of the shape factor not changing and being identical to that of the seed crystal and the latter method may further be somewhat effected by the loss of the product crystals from the reactor and during the washing, in the following, in calculations of d_p and GR, the linear growth rate, the mass method and equation 1 were used.

While the supersaturation level in the reactor is controlled by the temperature difference between the saturator and the reactor (this was varied between 2 and 10 degrees C) its effective level is given by the solute balance within the reactor. Both the inlet and outlet solution concentrations were measured at the start and end of each run. Their difference, that is expected to depend on the flow rate through the reactor - this varied from 45 to 60 ml/min - and the mass growth rate (g/min), was found to be significant (Figure 7) and, as the stirred reactor is expected to behave as an ideally stirred vessel rather than a plug flow reactor, the effective level of supersaturation was taken as that corresponding to the exit solution concentration and was calculated as

$$\sigma = (C_{out} \, / \, C_{eq}) - 1 \qquad (2)$$

where the concentrations C_{out} and C_{eq}, in kg/kg water, are respectively the concentrations at the outlet from the reactor (determined by refractometry of a 1:1 diluted sample) and the solubility of sucrose in pure solutions at the reactor

temperature (ref). The small amounts of dextran (on average around 800 ppm) were disregarded since the corrections to the sucrose concentration at the reactor outlet C'_{out} and the sucrose solubility C'_{eq} in the presence of small amounts of dextran are small and of same sign (salting-out of sucrose in the presence of saccharides)

$$C'_{out} = C_{out} - C_{dex} \qquad (3)$$

$$C'_{eq} = C_{eq} - dC_{eq} \qquad (4)$$

The solubility of sucrose in the presence of the salts used in some of the experiments was not determined and these were not used in the evaluation of the effects of the additives on the growth rate.

RESULTS/DISCUSSION

M_w, the weight average molecular weights of the source additives as well as those of the entrained polymers are summarized in Table I. Sample SEC/MALLS chromatograms of D1, D2 and a product are given in Figures 8 through 10. It is notable that the Mw of the polymer fractions crystallized is substantially higher than that of the fraction in the solution. Because the solution:product mass ratio ranged from 500 (5000 ml solution, 10 g crystals) to 50 (5000 ml solution, 100 g crystals) at the start and end of crystallization respectively, in the following it is assumed that both the total amount of the additive in the solution as well its M_w do not change during crystallization. The shift of M_w between the source and the entrained fractions that indicates higher entrainment rate for higher M_w fractions must, of course depend on the M_w distribution of the source additives. Since no polymerization/depolymerization reactions can be expected in our system, no shift would occur for monodisperse additives.

In the range of dextran concentrations between 300 and 1500 ppm and other conditions prevailent in our experiments, the growth rate is not noticably effected by the dextran concentration or molecular weight of the dextran (Figures 11 and 12). While the solution viscosity increases by about 10 and 1 % at 1000 ppm of D1 and D3 respectively (Greenfield and Geronimos, 1978), the mass transfer and crystallization rate may not decrease proportionately (Saska, 1989). The somewhat smaller scatter when the growth rate is plotted against the supersaturation (calculated from the reactor exit concentration, equation 2) as opposed to the undercooling, i.e. the temperature difference between the saturator and the reactor, indicates that the solution at the exit of the saturator may not have always been saturated due to the limited contact time in the saturator.
The dextran uptake is effected by its concentration in the solution, the crystallization velocity and the molecular weight of the dextran (Figures 13 and 14). The uptake data for D1 and D2 were fitted with a 3-parameter equation

$$C_c = (a_0 + a_1*GR) * C_s / (a_2 + C_s) \quad (5)$$

corresponding to a Langmuir type isotherm where both the slope at $C_s = 0$ as well as the plateau value ($1/C_s = 0$) are linear functions of the crystallization rate, GR. All the data used for the correlations are summarized in Tables II and III, together with the values of the parameters a_0, a_1 and a_2 as well as the predicted values. The two functions are plotted at the representative values of the two independent variables, the solution concentration of 600 ppm and the growth rate of 2 u/min in Figures 15 and 16 respectively. Also included are, for comparison sake, the experimental values for D3 that were too few to yield a meaningful correlation. The scatter of the data is considerable and it is by no means certain that other factors, not included in eq 5 do not effect the dextran uptake.

Table II: Uptake of D1 during sucrose crystallization. The predicted values were calculated from equation 5, with the following parameters:

a_0 = 693.8
a_1 = 38.9 min/u
a_2 = 1706.5 ppm

Run*	C_s ppm	C_c ppm	GR u/min	$C_{c,pred}$ ppm	$C_c - C_{c,pred}$ ppm
SSD4	767	243	2.47	245	-2
SSD5	821	296	4.83	286	10
SSD6	308	195	0.12	107	88
SSD10	714	217	1.27	219	-2
SSD11	1238	332	2.39	331	1
SAD10	401	56	0.98	139	-83

*** Note: SSXX runs done with dextran as the only additive, while in the SAXX runs KCl and NaCl were also added.**

Table III: Uptake of D2 during sucrose crystallization. The predicted values were calculated from equation 5, with the following parameters:

a_0 = 149.9
a_1 = 83.9 min/u
a_2 = 787.9 ppm

Run*	C_s ppm	C_c ppm	GR u/min	$C_{c,pred}$ ppm	$C_c - C_{c,pred}$ ppm
SSD7	1224	141	0.76	130	11
SSD8	1439	232	2.64	240	-8
SSD9	1124	289	4.09	290	-1
SSD12	589	171	3.47	189	-18
SSD13	543	158	1.75	121	37
SSD14	546	169	3.79	191	-22
SAD5	1039	69	1.15	140	-71
SAD6	851	255	2.11	170	85
SAD7	625	160	2.39	155	5
SAD8	490	90	0.71	80	10
SAD9	332	40	1.10	72	-32

* Note: SSXX runs done with dextran as the only additive, while in the SAXX runs KCl and NaCl were also added.

Table IV: Uptake of D3 during sucrose crystallization.

Run*	C_s ppm	C_c ppm	GR u/min
SSD1	1439	42	3.16
SSD2	1485	46	5.82
SSD3	906	67	6.70
SAD1	966	42	1.43

* Note: SSXX runs done with dextran as the only additive, while in the SAXX runs KCl and NaCl were also added.

The results of salt uptake are summarized in Table V.

Table V: Uptake of K and Na in sucrose crystallization

		Na		K	
Run	GR u/min	C_s ppm	C_c ppm	C_s ppm	C_c ppm
SAD1	1.43	2970	5.5	27200	40
SAD2	-	1740	4.0	20000	33
SAD3	-	2080	2.5	17300	21
SAD4	-	1630	2.6	15000	13
SAD5	1.15	1580	2.3	20700	17
SAD6	2.11	1550	5.0	14000	36

Note: The concentrations (by AAS) of the respective cation are in units of ppm on total dissolved solids (C_s) and ppm of mass of product crystals (C_c). The C_s are averages at the start and end of crystallization.

While the limited data on K and Na uptake does not allow firm conclusions, K, the partition coefficient (C_c/C_s) of potassium is, on average, 0.002 (std.dev. 0.0007, N=6), that of sodium 0.0015 (std.dev. 0.0007, N=6), indicating slightly lower uptake of sodium than potassium. This would be in line with the trend, seen clearly for the three fractions of dextrans, of increasing uptake with increasing M_w or size of the molecule.

REFERENCES

Austmeyer, K. E., Dissertation, Technische Universitat Braunschweig, 1980.

Greenfield, P. F. and G. L. Geronimos, Int. Sugar J., 80, 67, 1978.

Jackson, C., L. M. Nilssen and P. J. Wyatt, J. Appl. Polym. Sci., 43, 99, 1989.

Saska, M., Proc. XXth Congress ISSCT, Vol. 1, pp. 115 - 122, Sao Paulo, Brazil, 1989.

Saska, M., Int. Sugar J., 91, 109, 1989.

Schliephake, D., CITS Meeting, Vienna, 1989.

Vink, H. and G. Dahlstrom, Makrom. Chemie, 109, 249, 1967.

Wyatt, P. J., C. Jackson and G. K. Wyatt, American Laboratory, May, June, 1988.

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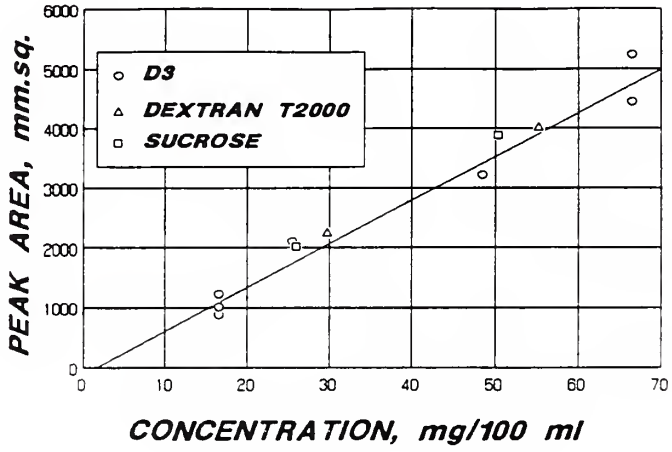

Figure 1: Standard curve for dextran determination on a SEC system consisting of 2 Waters' Ultrahydrogel 250 columns and an ERMA RI detector. Other parameters: Solvent: 0.1 N $NaNO_3$, flow rate: 0.5 ml/min, injection volume: 100 uL, sample dilution: app. 40 w % (total dissolved solids). Column and detector at room temperature.

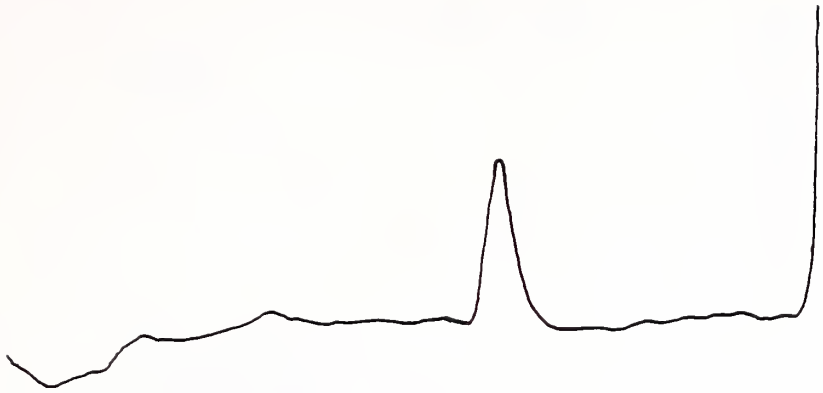

Figure 2: A sample SEC chromatogram, run SAD7, product crystals, dextran D2 used as an additive. The first, polysaccharide peak elutes at around 12 ml, followed by the sucrose/salt front at around 19 ml. Dextran concentration 152 ppm.

figure 3: A sample SEC chromatogram, run SSD1 - solution, dextran D3 used as an additive. The low M_w dextran peak (D3) elutes at around 17 ml followed by the sucrose/salt front at around 19 ml. Dextran concentration 1439 ppm.

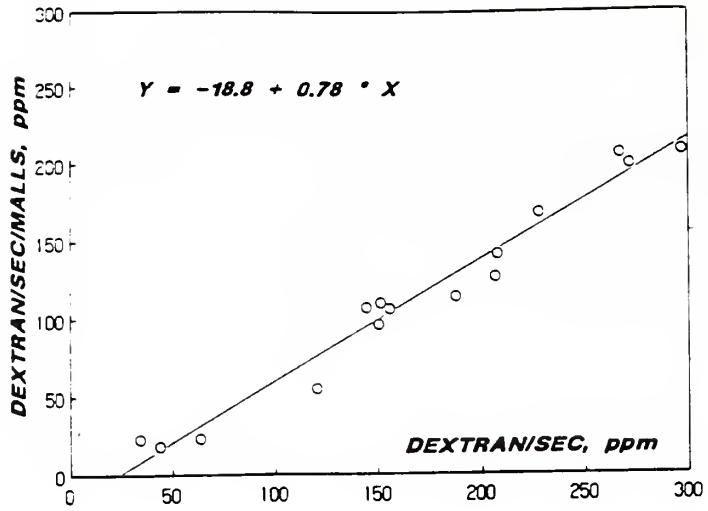

Figure 4: Dextran determination with a SEC system (see Figures 1, 2 and 3) and an SEC/MALLS system consisting of one Waters' Ultrahydrogel Linear column (at 55 C), Waters' 410 RI detector (at 40 C) and a MALLS laser scattering detector (DAWN model F). The peaks were integrated with the Wyatt ASTRA software using the dn/dC (concentration derivative of the refractive index) of dextran of 0.142 (Vink and Dahlstrom, 1967). Other parameters: Solvent: 0.1 N $NaNO_3$, flow rate: 0.5 ml/min, injection volume: 100 uL, sample dilution: app 40 w%. Y = dextran concentration (ppm) determined with SEC/MALLS, X = dextran concentration determined with SEC.

CRYSTALIZATION IN FLUIDIZED BED

Reheater Saturator Pump Fluidized Bed

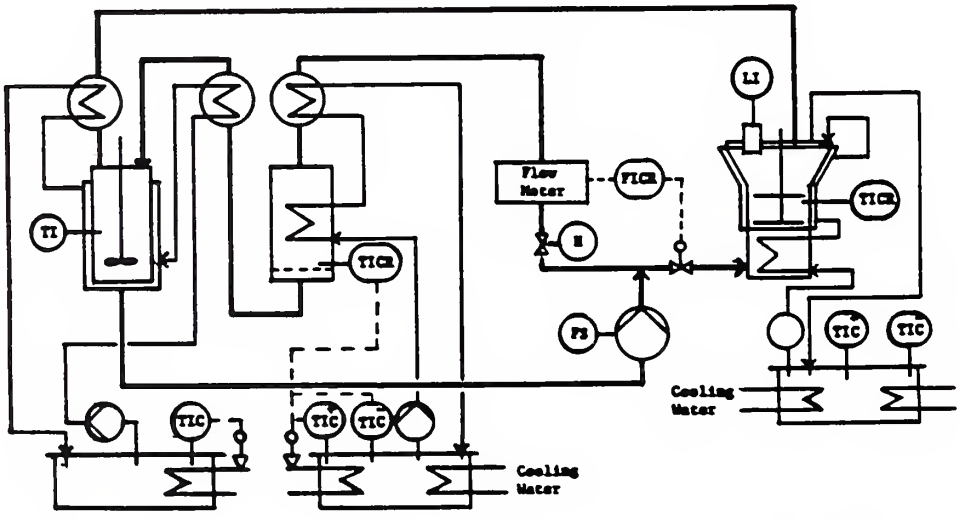

Figure 5: Schematic of the fluidized bed crystallizer, consisting of the dissolver, saturator, pump and the reactor.

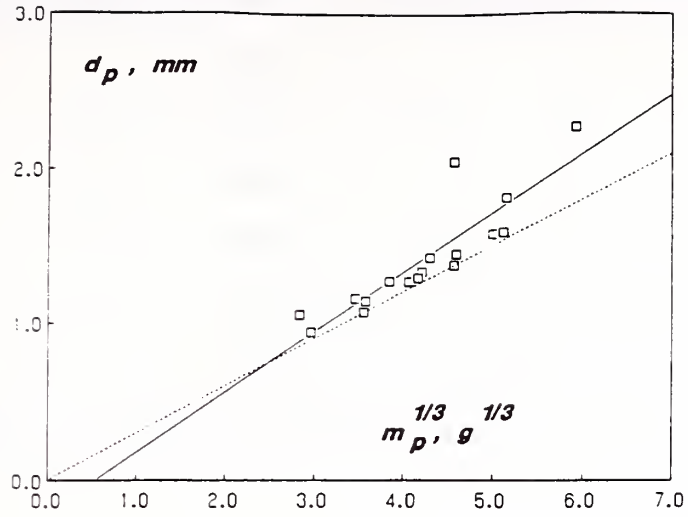

Figure 6: Crystal size determination. d_p = characteristic dimension of the crystal, m_p = mass of the product. Squares: experimental points (mass of product measured , size of the product crystals obtained from the microphotographs of the product crystals-MOP analysis (Austmeyer, 1980).Full line: least-square fit of the experimental points. Dotted line: mass of the product crystals measured, d_p calculated from equation 1. The deviation of the experimental points from the theoretical line (dotted) indicates either slight overestimation of d_p from the microphotographic analysis (undercount of the fine crystals) or a slight underestimation of m_p, mass of the product (losses from the reactor and/or during washing).

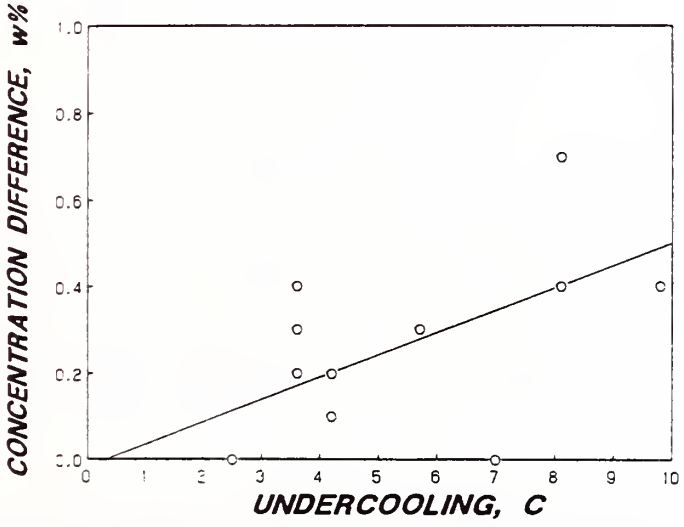

Figure 7: Concentration difference (reactor inlet vs. reactor outlet) vs. undercooling (temperature difference between the saturator and reactor). Concentrations determined by refractometry of 1:1 diluted solutions.

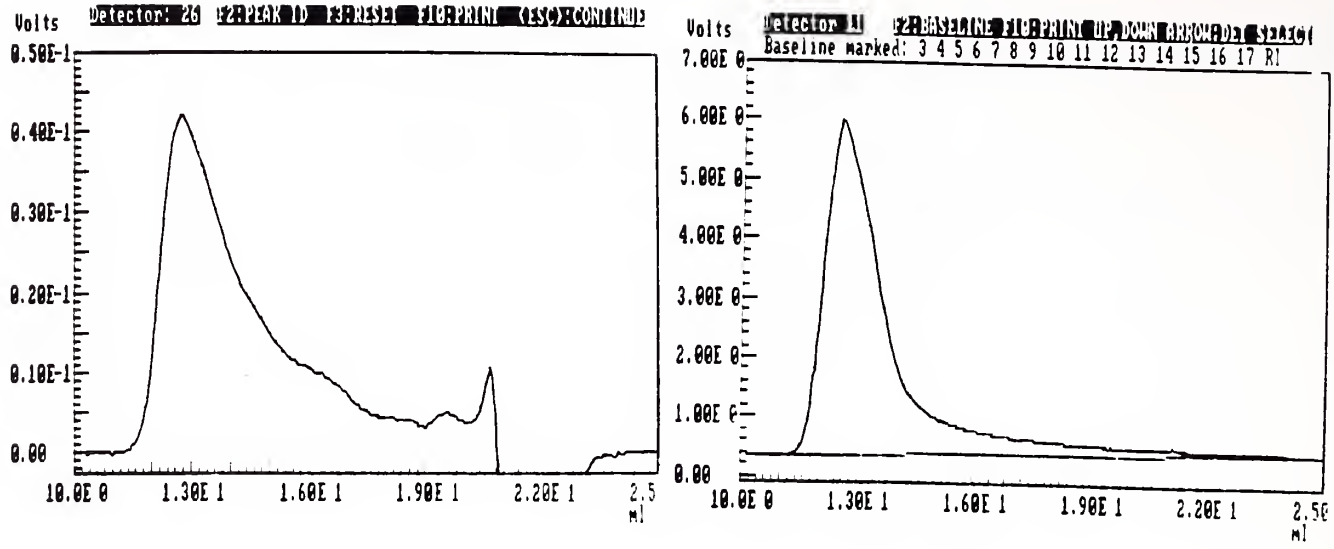

Figure 8: Sample SEC/MALLS chromatograms, dextran D1. Left: RI signal (detector 26), Right: MALLS laser light scattering signal, detector 11 at 90 degrees scattering angle). 0.1 % solution. Other parameters as in Figure 4.

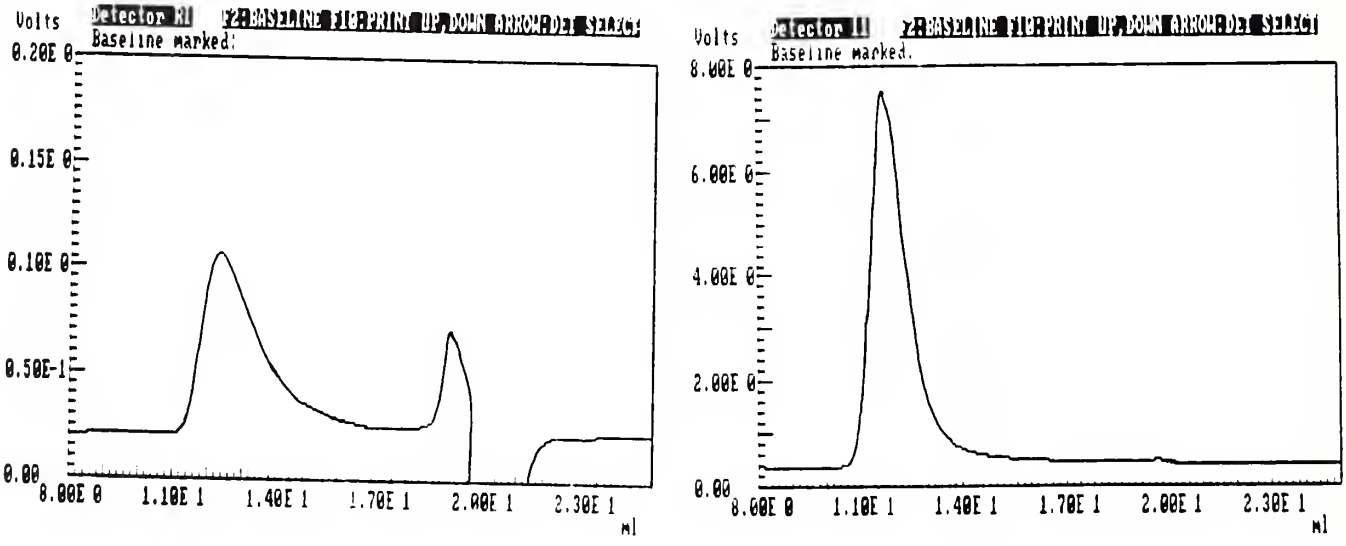

Figure 9: Sample SEC/MALLS chromatograms, dextran D2. Left: RI signal (detector 26), Right: MALLS laser light scattering signal, detector 11 at 90 degrees scattering angle). 0.1 % solution. Other parameters as in Figure 4.

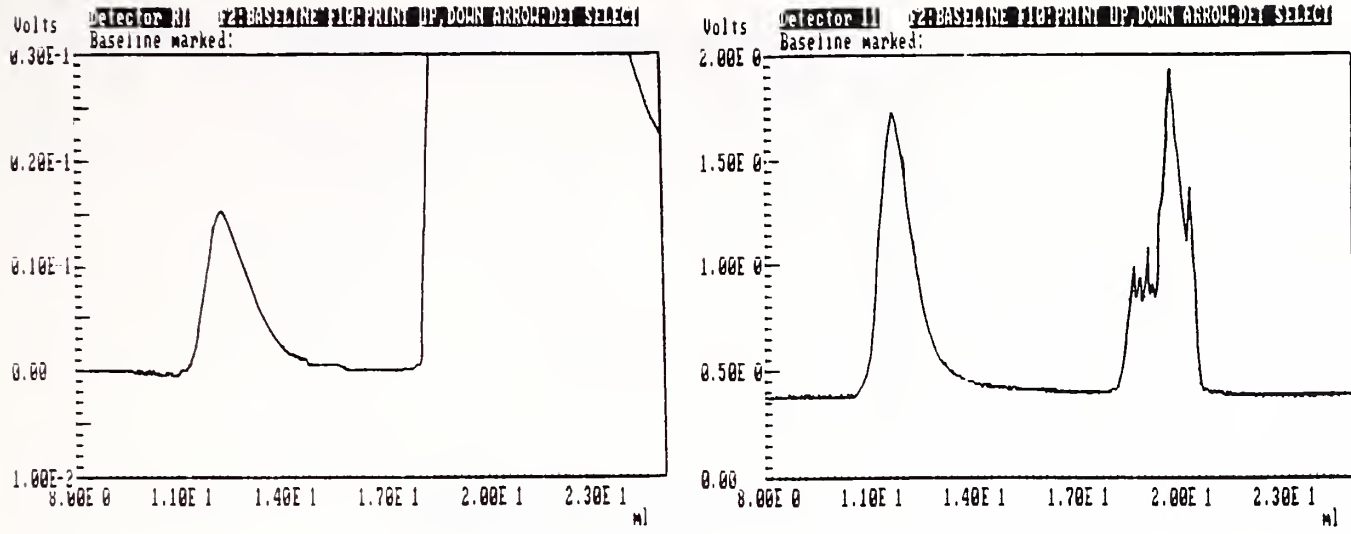

Figure 10: Sample SEC/MALLS chromatograms, run SSD9 - product crystals, D2 additive. Left: RI signal, Right: MALLS signal at 90 degrees scattering angle. The polymer peak at around 12 ml is followed by the sucrose front at around 18.3 ml. Note the noisy MALLS signal between 18 and 21 ml due probably to column shedding in the wake of the sucrose peak (sucrose molecule itself is too small to scatter light significantly).

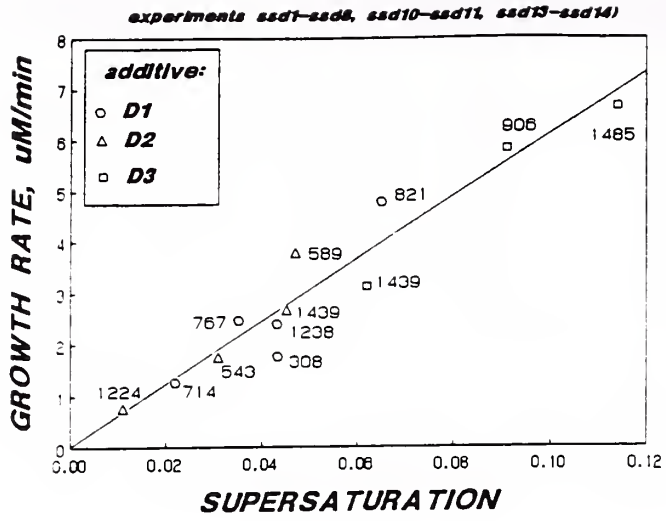

Figure 11: Crystal growth rate (u/min) vs. supersaturation. D1, D2 and D3 additives. The parameters next to the experimental points are the additive concentrations in solution (ppm).

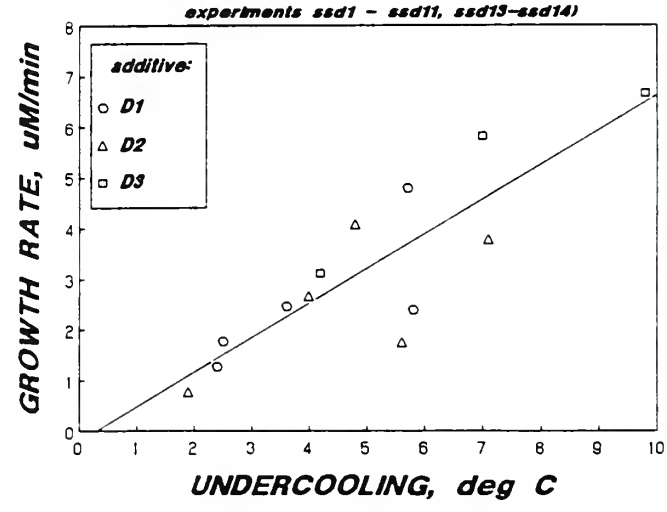

Figure 12: Crystal growth rate (u/min) vs. undercooling, i.e. the temperature difference between the saturator and the reactor.

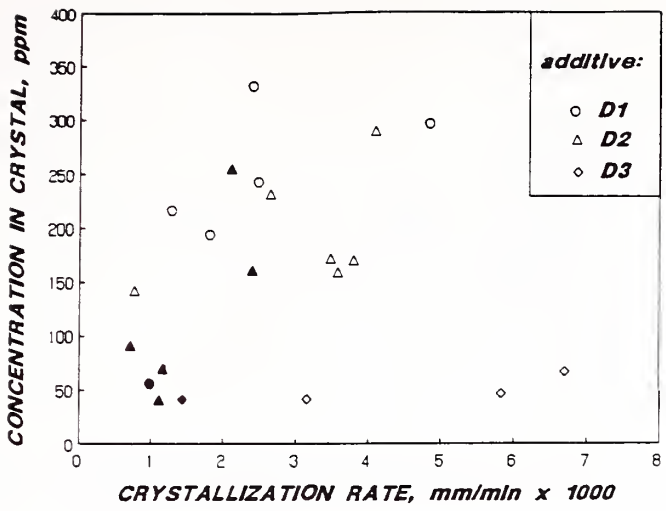

Figure 13: Dextran uptake in sucrose crystallization. The full symbols represent runs when in addition to D1, D2 or D3, KCl and NaCl were also added (concentrations in Table V).

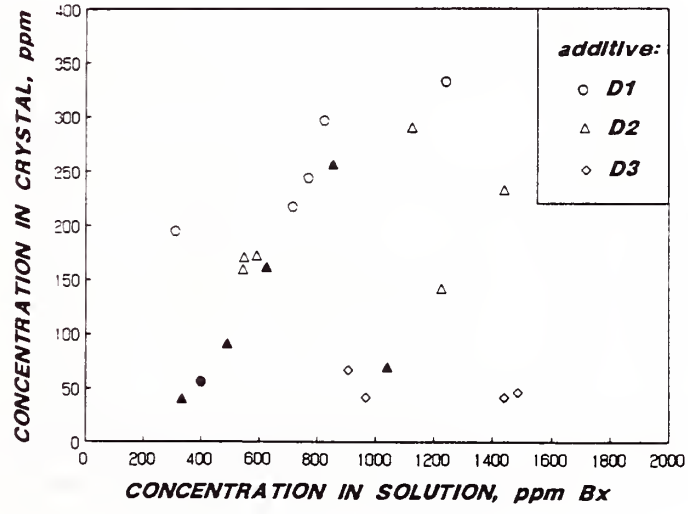

Figure 14: Dextran uptake in sucrose crystallization. The full symbols represent runs when in addition to D1, D2 or D3, KCl and NaCl were also added (concentrations in Table V).

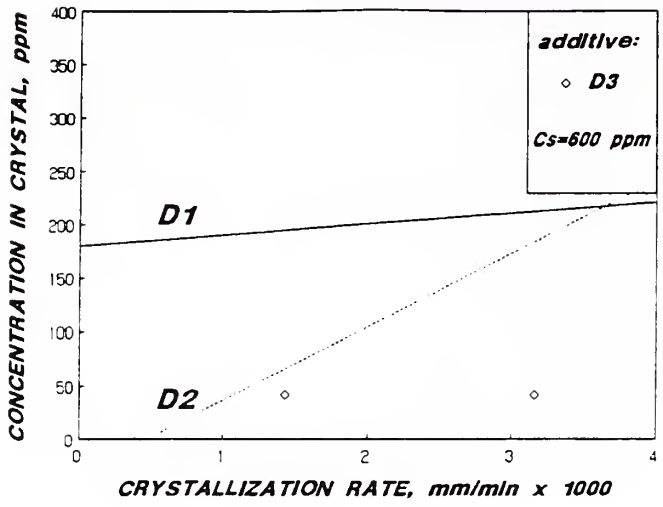

Figure 15: Dextran uptake in sucrose crystallization vs. crystallization rate. The lines represent equation 5 (with C_s = 600 ppm), parameters from Tables II and III. Diamonds: D3 experimental values.

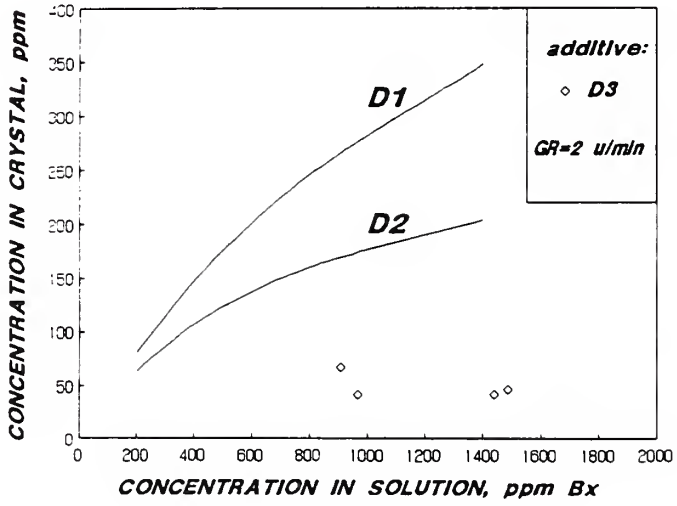

Figure 16: Dextran uptake in sucrose crystallization vs. solution concentration. The lines represent equation 5 (with GR, the growth rate of 2 u/min), parameters from Tables II and III. Diamonds: D3 experimental values.

1990 ASI FINAL MOLASSES SURVEY

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During the 1990 sugarcane grinding season, weekly composites of final molasses samples were sent to Audubon for analysis. Samples were analyzed for refractometer Brix, pol, sucrose, glucose, fructose, and conductivity ash. From these analyses true purity, target purity, total sugars and total sugars as invert were calculated. Table 1 shows results of the state average by week. Table 2 shows results of the crop average for each factory.

Table 1

1990 ASI FINAL MOLASSES SURVEY

STATE AVERAGE BY WEEK

Week Ending	Ref. Brix	App. Pty.	Glu.	Fruc.	RS	Cond. Ash	RS/ Ash	True Solids	True Suc.	True Pty.	Target Pty.	Diff.	Total Sugars	Ttl.Sug. Invert
11/03	83.5	34.04	5.04	8.54	13.57	11.70	1.17	82.44	36.29	44.02	41.69	2.33	49.86	51.77
11/10	81.9	36.25	4.36	7.14	11.50	11.91	0.97	80.80	35.22	43.61	42.63	0.99	46.72	48.57
11/17	81.9	35.54	3.91	6.73	10.64	12.12	0.88	80.79	35.84	44.35	43.16	1.19	46.51	48.37
11/24	81.9	35.96	3.38	6.19	9.58	12.48	0.77	80.83	36.69	45.40	43.89	1.51	46.27	48.20
12/01	81.4	40.09	3.12	5.39	8.51	12.55	0.68	80.33	36.62	45.61	44.57	1.04	45.13	47.05
12/08	81.7	39.47	3.35	5.53	8.88	12.99	0.69	80.63	36.13	44.78	44.49	0.30	45.01	46.91
12/15	82.4	38.22	4.62	6.28	10.90	13.52	0.82	81.36	36.23	44.50	43.61	0.90	47.13	49.03
12/22	82.6	36.97	5.20	6.33	11.53	12.65	0.93	81.52	36.70	45.01	43.09	1.92	48.23	50.16

Table 2

1990 ASI FINAL MOLASSES SURVEY

CROP AVERAGE BY FACTORY

Factory	Ref. Brix	App. Pty.	Glu.	Fruc.	RS	Cond. Ash	RS/ Ash	True Solids	True Suc.	True Pty.	Target Pty.	Diff.	Total Sugars	Ttl.Sug. Invert
A	80.7	40.62	3.62	5.58	9.20	12.35	0.74	79.62	37.17	46.70	44.09	2.61	46.37	48.32
B	80.1	40.17	2.88	4.91	7.79	12.34	0.63	79.01	36.16	45.79	44.89	0.90	43.95	45.86
C	80.5	37.07	3.34	5.70	9.04	12.00	0.75	79.43	35.56	44.76	43.94	0.82	44.60	46.47
D	80.3	35.62	3.92	6.24	10.16	12.93	0.79	79.25	34.20	43.17	43.73	-0.56	44.36	46.16
F	83.5	32.48	3.72	6.71	10.43	12.74	0.82	82.38	33.81	41.04	43.55	-2.51	44.23	46.01
G	83.1	35.59	3.33	5.84	9.17	12.76	0.72	81.97	37.19	45.38	44.29	1.08	47.04	48.32
H	84.2	38.31	4.88	6.82	11.70	13.32	0.89	83.08	37.23	44.81	43.20	1.61	48.92	50.88
I	81.8	32.59	5.62	8.00	13.60	11.72	1.17	80.70	33.39	41.37	41.60	-0.23	47.01	48.76
J	84.6	42.94	4.63	6.97	11.60	11.96	0.97	83.46	39.98	47.91	42.59	5.32	51.58	53.68
K	76.0	42.01	3.44	5.58	9.02	12.11	0.75	75.01	36.21	48.23	44.02	4.22	45.23	47.14
N	82.0	37.45	3.30	7.31	10.61	12.02	0.90	80.90	35.75	44.19	43.31	0.87	46.36	48.24
O	82.9	38.84	2.92	5.80	8.72	11.12	0.78	81.82	38.90	47.55	43.79	3.77	47.62	49.67
P	78.5	34.73	3.85	6.22	10.07	12.12	0.84	77.46	34.36	44.38	43.49	0.89	44.43	46.24
Q	81.1	36.84	2.38	5.58	7.96	13.37	0.60	80.02	33.88	42.34	45.25	-2.91	41.88	43.62
R	80.6	35.15	3.37	6.28	9.65	12.27	0.79	79.51	35.15	44.26	43.70	0.56	44.83	46.68
S	84.8	36.69	4.25	6.98	11.24	13.12	0.86	83.69	37.81	45.18	43.29	1.89	49.05	51.04
W	83.9	39.87	4.33	6.46	10.79	12.51	0.87	82.79	38.89	46.97	43.19	3.78	49.74	51.72

1990 BOILER PROJECT

Harold Birkett and Jeanie Stein
Audubon Sugar Institute

Introduction

The American Sugar Cane League funded a study to investigate bagasse boiler efficiency and operating conditions at Louisiana raw sugar factories. The study is expected to be a two year study. Data collection started with the 1990 sugarcane crop. The 1990 crop was short due to the freeze damage at the end of the 1989 crop.

In 1990 boiler tests were conducted at 10 of the state's 19 operating factories witn data collected on 45 boilers. Some boilers were tested on several occasions and 101 individual boiler tests were run.

Data Collected

The data collected is summarized in Table 1. The data collected included the steam flow, steam pressure and steam temperature. The maximum, minimum and average furnace temperature in each of the furnace cells were recorded along with the pile heights in each cell. The temperature of the preheated combustion air leaving the air preheater, the static pressure of the forced draft fan and the plenum air pressure, and the RPM of the forced draft fan. The temperature of the flue gases leaving the boiler, the temperature of the flue gases leaving the air preheater, the draft at the induced draft fan suction, the discharge pressure of the induced draft fan, and the RPM of the induced draft fan. The flue gas was analyzed for % oxygen. The lack of certain data for a run generally indicates that it was not possible to obtain that data.

Samples of mill run bagasse were taken during the boiler tests and the bagasse was analyzed for moisture and ash content.

Data Handling

A computer program was written to accept the data and calculate all of the flue gas components and weights. The program was also used to calculate the quantity of excess air, the theoretical maximum boiler efficiency (assuming no radiation or blowdown losses), the expected boiler outlet gas temperature, the quantity of bagasse burned, and the steam production per pound of bagasse.

The program also calculates the volume of combustion air, the volume of flue gases, and the overall heat transfer coefficient achieved in the air preheater.

Results

The results are tabulated in Table 2, and include the calculated excess air figure, the boiler efficiency (assuming 3% radiation and other heat losses), the theoretical maximum furnace temperature, the calculated boiler outlet temperature, the quantity of bagasse required for the measured steam production, and the steam production per pound of bagasse.

The range in the measured variables is shown below:

	Low	High	Average
Furnace Temperature, F	654	2130	1425
Preheated Air Temp., F	211	520	412
Plenum Air Pressure, Ins. water	0.3	7.2	1.7
I.D. Fan Suction, Ins. water	1.6	10.0	5.6
I.D. Fan Discharge, Ins. water	-2.1	7.9	3.2
I.D. Fan Delta, Ins. water	2.0	14.9	8.8
I.D. Fan Speed, RPM	660	1280	980
Stack Gas Temp., F	236	600	431
Moisture % Bagasse	50.2	59.2	55.2
Asn % Bagasse	1.1	9.6	2.7
Air Preheater tube wall temperature at air inlet, F	108	314	198
Flue Gas, % Oxygen	3.0	20.0	9.6
Excess Air, %	9	612	93
Boiler Efficiency (3% Losses)	25.9	66.4	55.1

Theoretical Predictions

Tables 3 through 8 snow the calculated excess air, the maximum theoretical furnace temperature, and the boiler efficiency for various flue gas temperatures as a function of oxygen content of the flue gases. The tables cover a moisture % bagasse range from 50 to 64%.

The calculated maximum furnace temperatures assume that the combustion air has been preheated to 400 deg. F - the average figure measured this year. It has also been assumed that combustion is complete.

Some of the data from Tables 3 through 8 was used to prepare the graphs attached.

Table 1

1990 BOILER DATA

Mill	Date	Run No.	Boiler No.	Steam lb/hr	Steam psig	Temperature, deg. F Furn.	Prhtr.	Flue	Draft, " Water F.D.	I.D. Suct.	I.D. Disch.	I.D. Fan RPM	Flue Gas % O2	Bagasse % Moist.	Bagasse % Ash
A	12/10	1	1	100,000	190	-	(400)	402	-	5.0	-	700	8.1	55.25	2.66
A	12/10	1	3	60,000	187	-	400	471	-	5.3	-	590	11.9	55.25	2.66
A	12/10	1	4	90,000	190	-	(500)	432	-	5.1	-	600	12.3	55.25	2.66
A	12/10	1	5	137,000	197	-	500	485	-	7.0	-	980	5.8	55.25	2.66
B	11/14	1	1	91,000	213	-	385	403	-	5.6	-	909	8.7	52.12	1.87
B	11/14	1	2	115,700	216	-	430	416	-	4.3	-	1000	9.1	52.12	1.87
B	11/14	1	3	109,200	220	-	415	413	-	-	-1.1	1185	8.2	52.12	1.87
B	11/14	1	4	94,900	216	-	435	421	-	8.0	-	1045	10.7	52.12	1.87
C	12/03	1	3	62,000	215	-	(275)	600	-	5.3	-	1180	8.6	55.80	1.99
C	12/03	1	5	44,000	212	-	(77)	488	-	3.9	-	1145	12.2	55.80	1.99
C	12/03	2	5	44,000	212	-	(77)	537	-	4.5	-	1171	7.5	55.80	1.99
D	12/07	1	1	62,500	212	-	451	380	-	5.4	-	1027	18.0	57.51	9.56
D	12/07	1	2	12,500	208	-	211	309	-	3.0	-	1048	18.0	57.51	9.56
D	12/07	1	3	28,140	207	-	356	284	-	3.4	-	891	15.0	57.51	9.56
D	12/07	1	4	46,900	199	-	394	365	-	4.2	-	1030	16.5	57.51	9.56
D	12/07	1	5	85,800	219	-	290	334	-	5.0	-	810	18.0	57.51	9.56
E	10/30	1	5	40,000	153	-	330	452	-	7.0	-	-	7.5	55.76	1.47
E	10/30	1	6	13,000	220	-	330	452	-	7.0	-	-	7.5	55.76	1.47
E	10/31	1	5	46,000	152	-	335	519	1.8	6.8	-	-	5.0	(55.76)	(1.47)
E	10/31	1	6	42,000	242	-	335	519	1.8	6.8	-	-	5.0	(55.76	(1.47)
E	10/31	1	7	45,100	172	-	285	360	1.7	6.3	-	-	15.0	(55.76)	(1.47)
E	11/02	1	1	79,100	176	-	418	417	1.0	-	-	-	10.9	55.54	1.48
E	11/02	1	2	25,000	170	-	418	417	1.7	-	-	-	10.9	55.54	1.48
E	11/02	1	5	40,000	164	-	335	487	0.7	-	-	-	7.9	55.54	1.48
E	11/02	1	6	38,000	240	-	335	487	0.7	-	-	-	7.9	55.54	1.48
E	11/02	1	7	72,600	190	-	299	365	3.0	10.0	-	-	12.7	55.54	1.48
E	11/02	2	1	66,000	195	-	430	410	1.5	4.5	-	-	8.5	55.54	1.48
E	11/02	2	2	24,000	190	-	435	410	1.6	4.5	-	-	8.5	55.54	1.48
E	11/02	2	5	50,000	188	-	398	480	1.0	6.1	-	-	10.1	55.54	1.48
E	11/02	2	6	38,000	237	-	395	480	1.3	6.1	-	-	10.1	55.54	1.48
E	11/02	2	7	51,700	195	-	276	395	1.8	-	-	-	12.2	55.54	1.48
E	11/05	1	1	68,000	167	-	420	396	1.3	4.4	1.8	800	10.5	55.46	2.66
E	11/05	1	2	19,000	180	-	418	396	1.5	4.4	1.8	800	10.5	55.46	2.66
E	11/05	1	5	50,000	166	-	436	451	1.3	4.4	-	1050	9.5	55.46	2.66
E	11/05	1	6	38,000	235	-	440	451	1.1	4.4	-	1050	9.5	55.46	2.66

- means no data.
() means figure assumed to permit calculations.

Table 1 (Cont'd)

1990 BOILER DATA

Mill	Date	Run No.	Boiler No.	Steam		Temperature, deg. F			Draft, " Water			I.D. Fan RPM	Flue Gas % O2	Bagasse	
										I.D.				%	%
				lb/hr	psig	Furn.	Prhtr.	Flue	F.D.	Suct.	Disch.			Moist.	Ash
E	11/05	1	7	73,700	182	-	247	382	3.9	6.2	2.3	-	11.6	55.46	2.66
E	11/05	2	1	69,000	195	-	429	380	1.8	4.6	1.9	-	9.9	55.46	2.66
E	11/05	2	2	21,000	180	-	422	380	2.2	4.6	-	-	9.9	55.46	2.66
E	11/05	2	5	50,000	172	-	440	454	1.1	5.7	-	-	10.4	55.46	2.66
E	11/05	2	6	33,000	230	-	441	454	1.3	5.7	-	-	10.4	55.46	2.66
E	11/05	2	7	49,500	200	-	246	371	2.9	7.0	1.9	-	11.6	55.46	2.66
E	11/14	1	1	75,000	193	1723	450	414	1.5	4.4	2.3	835	7.5	53.38	2.33
E	11/14	1	2	26,000	185	1735	450	414	1.9	4.4	2.3	835	7.5	53.38	2.33
E	11/14	1	5	50,000	184	1466	414	427	1.3	6.6	-	743	11.5	53.38	2.33
E	11/14	1	6	40,000	233	1302	411	427	1.3	6.6	-	743	11.5	53.38	2.33
E	11/14	1	7	66,000	190	1550	266	385	3.2	8.7	-	1132	11.3	53.38	2.33
E	12/12	1	1	65,000	165	1425	412	393	1.4	3.8	2.5	953	9.7	57.20	1.79
E	12/12	1	2	18,000	167	1096	404	393	1.4	3.8	2.5	953	9.7	57.20	1.79
E	12/12	1	3	-	120	1570	-	-	0.8	-	-	-	-	57.20	1.79
E	12/12	1	4	-	118	1103	-	-	2.0	-	-	-	-	57.20	1.79
E	12/12	1	5	50,000	132	-	428	416	0.7	6.2	-	1255	8.4	57.20	1.79
E	12/12	1	6	38,000	225	-	428	416	0.7	6.2	-	1255	8.4	57.20	1.79
E	12/12	1	7	78,100	180	704	278	368	7.2	5.0	-	1136	12.9	57.20	1.79
F	11/12	1	1	24,000	197	1177	492	405	1.7	7.6	-	891	11.9	54.15	2.07
F	11/12	1	2	21,000	197	1320	478	405	2.0	7.6	-	891	11.9	54.15	2.07
F	11/12	1	3	36,000	200	1416	413	405	2.1	2.6	-	891	11.9	54.15	2.07
F	11/12	1	4	24,000	200	1409	476	477	2.0	9.0	-	1135	9.6	54.15	2.07
F	11/12	1	5	77,000	200	1394	390	515	-	5.0	-	1245	11.2	54.15	2.07
F	11/20	1	1	29,000	191	1339	470	475	1.7	8.3	-	918	10.3	58.82	1.11
F	11/20	1	2	43,000	195	1348	472	475	1.8	8.3	-	918	10.3	58.82	1.11
F	11/20	1	3	49,000	197	1686	422	475	1.8	8.3	-	918	10.3	58.82	1.11
F	11/20	1	4	48,000	205	1544	497	499	2.0	10.5	-	1183	10.2	58.82	1.11
F	11/20	1	5	87,000	205	1490	395	485	-	6.5	-	1277	11.6	58.82	1.11
F	12/06	1	1	37,500	176	1360	475	385	1.8	10.0	-	930	13.1	56.98	5.45
F	12/06	1	2	50,000	182	1280	472	385	1.9	10.0	-	930	13.1	56.98	5.45
F	12/06	1	3	47,000	180	1346	450	385	2.0	10.0	-	930	13.1	56.98	5.45
F	12/06	1	4	50,000	186	1575	491	493	2.1	8.0	-	1168	7.7	56.98	5.45
F	12/06	1	5	85,000	188	1565	350	492	-	5.3	-	1266	9.0	56.98	5.45
I	11/09	1	1	10,000	148	-	395	236	-	-	-	661	13.3	53.81	5.83
I	11/09	1	2	20,000	155	-	395	236	-	-	-	661	13.3	53.81	5.83

- means no data.

Table 1 (Cont'd)

1990 BOILER DATA

Mill	Date	Run No.	Boiler No.	Steam lb/hr	Steam psig	Temperature, deg. F Furn.	Temperature, deg. F Prhtr.	Temperature, deg. F Flue	Draft, " Water F.D.	Draft, " Water I.D. Suct.	Draft, " Water I.D. Disch.	I.D. Fan RPM	Flue Gas % O2	Bagasse % Moist.	Bagasse % Ash
I	11/09	1	3	18,000	150	-	390	237	-	-	-	661	13.3	53.81	5.83
I	11/09	1	4	35,000	190	-	448	457	1.7	1.7	-	752	3.9	53.81	5.83
I	11/09	1	5	31,000	235	-	460	457	-	1.9	0.7	752	3.9	53.81	5.83
I	11/09	1	6	87,500	245	-	490	422	-	3.0	6.2	997	7.9	53.81	5.83
I	11/12	1	1	16,000	150	1318	384	251	-	5.6	-	660	11.4	52.61	2.70
I	11/12	1	2	25,500	158	1216	384	251	-	5.6	-	660	11.4	52.61	2.70
I	11/12	1	3	17,000	161	1367	384	251	2.3	5.6	-	660	11.4	52.61	2.70
I	11/12	1	4	42,000	235	1939	469	469	1.5	1.6	-	797	3.0	52.61	2.70
I	11/12	1	5	35,000	250	1822	472	469	-	1.6	0.8	797	3.0	52.61	2.70
I	11/12	1	6	102,500	245	1461	520	445	-	3.3	7.9	1005	5.6	52.61	2.70
I	12/06	1	4	40,000	235	1565	468	480	-	-	1.4	944	8.3	52.38	1.36
I	12/06	1	5	40,000	250	1436	481	480	-	2.5	1.5	944	8.3	52.38	1.36
I	12/06	1	6	100,000	-	-	515	437	-	3.1	-	1018	5.6	52.38	1.36
I	12/14	1	5	-	-	-	-	486	-	-	-	-	6.7	-	-
I	12/14	1	6	128,750	-	1376	525	441	-	3.1	5.2	1013	7.0	-	-
J	11/20	1	1	88,000	245	-	-	420	-	5.8	-	853	7.8	50.15	1.65
J	11/20	1	2	115,000	250	-	-	406	-	6.1	-	843	11.5	50.15	1.65
J	11/20	1	3	110,000	230	-	-	418	-	4.9	-	1032	10.5	50.15	1.65
J	11/20	1	4	90,000	235	-	-	405	-	4.2	-	997	4.0	50.15	1.65
S	11/15	1	8	105,000	218	1078	428	385	0.8	7.8	7.1	973	12.3	57.16	1.55
S	11/19	1	5	96,000	222	-	-	487	-	4.1	-2.1	861	8.6	58.12	1.81
S	11/19	1	6	-	-	-	-	407	-	6.9	6.5	-	6.3	58.12	1.81
S	11/19	1	8	-	-	-	438	394	0.6	7.4	7.1	997	11.7	58.12	1.81
S	11/19	2	8	135,000	232	-	-	402	-	6.3	6.4	929	7.4	58.12	1.81
S	11/27	1	8	131,385	233	-	411	393	-	7.2	6.5	989	8.4	57.67	1.94
W	11/26	1	1	25,000	172	1541	450	426	-	6.2	5.0	974	12.2	54.50	1.76
W	11/26	1	2	30,000	170	1329	430	426	-	6.2	5.0	974	12.2	54.50	1.76
W	11/26	1	3	20,000	165	-	428	470	-	5.1	6.2	960	12.2	54.50	1.76
W	11/26	1	4	25,000	170	-	415	470	-	5.1	6.2	960	12.2	54.50	1.76
W	11/26	1	6	80,000	180	1254	-	389	-	10.0	4.2	1059	6.0	54.50	1.76
W	11/26	1	7	75,000	190	1281	430	435	0.3	5.3	4.4	920	9.7	54.50	1.76

- means no data.

Table 2

1990 BOILER RESULTS

Mill	Date	Run No.	Boiler No.	Excess Air %	Boiler Effic. %	Temperature, F Theor. Furnace	Temperature, F Boiler Outlet	Bagasse Fired Lb/Hr	Lbs Steam/ Lb Bagasse
A	12/10	1	1	62.27	60.04	1990	625	46,406	2.15
A	12/10	1	3	129.73	52.28	1654	712	31,966	1.87
A	12/10	1	4	140.75	53.85	1616	752	46,561	1.93
A	12/10	1	5	37.32	58.07	2208	758	65,750	2.08
B	11/14	1	1	70.34	62.19	2019	623	36,812	2.47
B	11/14	1	2	75.87	61.16	2010	670	47,600	2.43
B	11/14	1	3	63.13	61.77	2076	652	44,495	2.45
B	11/14	1	4	101.96	58.58	1856	687	40,763	2.32
C	12/03	1	3	66.29	49.43	1923	734	34,892	1.77
C	12/03	1	5	132.12	47.83	1590	488	25,588	1.71
C	12/03	2	5	54.21	54.32	2022	536	22,530	1.95
D	12/07	1	1	611.57	25.86	902	707	87,017	0.71
D	12/07	1	2	611.57	35.81	698	427	12,568	0.99
D	12/07	1	3	250.78	52.36	1188	508	19,348	1.45
D	12/07	1	4	369.76	40.20	1046	629	41,989	1.11
D	12/07	1	5	611.57	32.32	765	522	95,643	0.89
E	10/30	1	5	51.37	55.78	1961	622	19,608	2.03
E	10/30	1	6	51.37	55.78	1961	622	6,400	2.03
E	10/31	1	5	15.35	43.80	1947	676	28,711	1.60
E	10/31	1	6	15.35	43.80	1947	676	26,356	1.59
E	10/31	1	7	248.28	51.86	1229	531	23,813	1.89
E	11/02	1	1	105.54	56.64	1771	667	38,018	2.07
E	11/02	1	2	105.54	56.64	1771	667	12,026	2.07
E	11/02	1	5	57.92	55.68	1956	662	19,564	2.04
E	11/02	1	6	57.92	55.68	1956	662	18,666	2.03
E	11/02	1	7	150.70	57.20	1517	536	34,632	2.09
E	11/02	2	1	61.13	55.12	1924	653	32,681	2.01
E	11/02	2	2	61.13	55.12	1928	657	11,880	2.02
E	11/02	2	5	91.34	54.60	1826	709	24,983	2.00
E	11/02	2	6	91.34	54.60	1824	707	19,035	1.99
E	11/02	2	7	138.41	57.62	1553	527	24,487	2.11
E	11/05	1	1	90.16	57.84	1788	643	32,869	2.06
E	11/05	1	2	90.16	57.84	1787	641	9,192	2.06
E	11/05	1	5	79.45	54.88	1871	703	25,470	1.96
E	11/05	1	6	79.45	54.88	1873	706	19,434	1.95

- means no data.

Table 2 (Cont'd)

1990 BOILER RESULTS

Mill	Date	Run No.	Boiler No.	Excess Air %	Boiler Effic. %	Temperature, F Theor. Furnace	Temperature, F Boiler Outlet	Bagasse Fired Lb/Hr	Lbs Steam/ Lb Bagasse
E	11/05	1	7	122.65	57.37	1581	510	35,953	2.04
E	11/05	2	1	87.73	58.81	1848	633	32,862	2.09
E	11/05	2	2	87.73	58.81	1843	628	9,992	2.10
E	11/05	2	5	93.94	53.86	1803	714	25,960	1.92
E	11/05	2	6	93.94	53.86	1803	715	17,190	1.91
E	11/05	2	7	121.89	58.23	1588	498	23,815	2.07
E	11/14	1	1	47.69	55.72	2039	667	36,181	2.07
E	11/14	1	2	47.69	55.72	2039	667	12,537	2.07
E	11/14	1	5	117.13	55.11	1724	680	24,376	2.05
E	11/14	1	6	117.13	55.11	1722	678	19,551	2.04
E	11/14	1	7	116.12	59.47	1669	528	29,830	2.21
E	12/12	1	1	84.01	57.14	1821	630	32,475	2.00
E	12/12	1	2	84.01	57.14	1816	625	8,994	2.00
E	12/12	1	3	-	-	-	-	-	-
E	12/12	1	4	-	-	-	-	-	-
E	12/12	1	5	63.12	55.88	1914	655	25,464	1.96
E	12/12	1	6	63.12	55.88	1914	655	19,481	1.95
E	12/12	1	7	158.88	55.36	1446	523	40,311	1.93
F	11/12	1	1	126.14	55.63	1733	718	11,503	2.08
F	11/12	1	2	126.14	55.63	1724	708	10,065	2.08
F	11/12	1	3	126.14	55.63	1681	659	17,257	2.08
F	11/12	1	4	82.31	56.28	1947	761	11,372	2.11
F	11/12	1	5	113.15	52.23	1743	746	39,309	1.95
F	11/20	1	1	95.14	52.17	1783	751	16,136	1.79
F	11/20	1	2	95.14	52.17	1785	753	23,931	1.79
F	11/20	1	3	95.14	52.17	1754	718	27,274	1.79
F	11/20	1	4	93.81	51.40	1811	794	27,133	1.76
F	11/20	1	5	122.82	50.04	1627	717	50,510	1.72
F	12/06	1	1	165.25	52.22	1522	688	22,166	1.69
F	12/06	1	2	165.25	52.22	1521	687	29,567	1.69
F	12/06	1	3	165.25	52.22	1505	669	27,789	1.69
F	12/06	1	4	55.50	52.25	1952	764	29,560	1.69
F	12/06	1	5	73.95	52.15	1793	677	50,352	1.68
I	11/09	1	1	171.56	62.98	1499	490	4,636	2.15
I	11/09	1	2	171.56	62.98	1499	490	9,278	2.15

- means no data.

Table 2 (Cont'd)

1990 BOILER RESULTS

Mill	Date	Run No.	Boiler No.	Excess Air %	Boiler Effic. %	Temperature, F Theor. Furnace	Temperature, F Boiler Outlet	Bagasse Fired Lb/Hr	Lbs Steam/ Lb Bagasse
I	11/09	1	3	171.56	62.98	1496	486	8,347	2.15
I	11/09	1	4	18.64	56.50	2236	686	18,144	1.92
I	11/09	1	5	18.64	56.50	2242	693	16,108	1.92
I	11/09	1	6	58.72	58.76	2046	703	43,735	2.00
I	11/12	1	1	117.21	66.38	1752	488	6,306	2.53
I	11/12	1	2	117.21	66.38	1752	488	10,057	2.53
I	11/12	1	3	117.21	66.38	1752	488	6,706	2.53
I	11/12	1	4	8.58	54.58	2330	709	20,240	2.07
I	11/12	1	5	8.58	54.58	2331	711	16,877	2.07
I	11/12	1	6	35.41	61.88	2319	738	43,586	2.35
I	12/06	1	4	64.04	58.72	2095	754	17,047	2.34
I	12/06	1	5	64.04	58.72	2103	763	17,058	2.34
I	12/06	1	6	35.16	62.17	2242	729	40,277	2.48
I	12/14	1	5	-	-	-	-	-	-
I	12/14	1	6	-	-	-	-	-	-
J	11/20	1	1	54.43	60.29	2112	683	35,605	2.47
J	11/20	1	2	119.69	60.03	1795	692	46,741	2.46
J	11/20	1	3	97.94	60.23	1893	697	44,527	2.47
J	11/20	1	4	17.69	60.72	2370	648	36,143	2.49
S	11/15	1	1	139.20	55.38	1614	651	54,311	1.93
S	11/19	1	5	67.84	53.94	1888	731	52,177	1.83
S	11/19	1	6	41.68	58.87	2051	641	67,726	1.99
S	11/19	1	8	125.47	55.07	1653	661	72,405	1.86
S	11/19	2	8	53.84	58.53	1974	643	68,129	1.98
S	11/27	1	8	66.59	58.60	1917	622	65,234	2.01
W	11/26	1	1	137.43	54.99	1679	710	12,174	2.05
W	11/26	1	2	137.43	54.99	1666	695	14,606	2.05
W	11/26	1	3	136.13	51.97	1657	735	10,299	1.94
W	11/26	1	4	136.13	51.97	1649	725	12,879	1.94
W	11/26	1	6	35.90	59.62	2153	622	35,949	2.22
W	11/26	1	7	85.13	58.11	1886	688	34,604	2.16

- means no data.

Table 3

BOILER EFFICIENCY

Moisture % Bagasse = 50
Theoretical (no heat losses)

% Oxygen	% Excess Air	Temp. F Furnace	Flue Gas Temperature, deg. F 200	300	400	500	600	700	800
0.0	0.0	2756	76.83	74.11	71.34	68.54	65.68	62.78	59.83
5.0	31.0	2410	76.16	72.89	69.58	66.22	62.80	59.33	55.81
10.0	90.5	1973	74.88	70.57	66.20	61.77	57.28	52.72	48.10
15.0	250.8	1394	71.44	64.31	57.10	49.81	42.41	34.92	27.33
18.0	611.6	945	63.70	50.23	36.62	22.86	8.93	-	-

Table 4

BOILER EFFICIENCY

Moisture % Bagasse = 52
Theoretical (no heat losses)

% Oxygen	% Excess Air	Temp. F Furnace	Flue Gas Temperature, deg. F 200	300	400	500	600	700	800
0.0	0.0	2688	75.74	72.97	70.16	67.31	64.41	61.46	58.47
5.0	31.0	2357	75.07	71.76	68.40	64.99	61.53	58.01	54.44
10.0	90.5	1935	73.79	69.44	65.02	60.55	56.01	51.40	46.73
15.0	250.8	1374	70.35	63.18	55.92	48.58	41.14	33.60	25.96
18.0	611.6	935	62.61	49.09	35.44	21.63	7.06	-	-

Table 5

BOILER EFFICIENCY

Moisture % Bagasse = 54
Theoretical (no heat losses)

% Oxygen	% Excess Air	Temp. F Furnace	Flue Gas Temperature, deg. F 200	300	400	500	600	700	800
0.0	0.0	2616	74.55	71.74	68.88	65.98	63.03	60.03	56.98
5.0	31.0	2301	73.89	70.53	67.12	63.66	60.15	56.58	52.95
10.0	90.5	1896	72.61	68.20	63.74	59.22	54.63	49.97	45.24
15.0	250.8	1352	69.17	61.95	54.64	47.25	39.76	32.16	24.47
18.0	611.6	924	61.43	47.86	34.16	20.30	6.27	-	-

Table 6

BOILER EFFICIENCY

Moisture % Bagasse = 56
Theoretical (no heat losses)

% Oxygen	% Excess Air	Temp. F Furnace	Flue Gas Temperature, deg. F 200	300	400	500	600	700	800
0.0	0.0	2541	-	70.39	67.48	64.52	61.52	58.46	55.35
5.0	0.0	2241	72.59	69.18	65.72	62.21	58.64	55.01	51.33
10.0	90.5	1853	71.32	66.86	62.34	57.76	53.12	48.40	43.62
15.0	250.8	1329	67.88	60.60	53.24	45.79	38.25	30.60	22.84
18.0	611.6	913	60.13	46.51	32.76	18.84	4.77	-	-

Table 7

BOILER EFFICIENCY

Moisture % Bagasse = 58
Theoretical (no heat losses)

% Oxygen	% Excess Air	Temp. F Furnace	Flue Gas Temperature, deg. F 200	300	400	500	600	700	800
0.0	0.0	2462	-	68.92	65.95	62.93	59.86	56.75	53.57
5.0	31.0	2178	71.18	67.71	64.19	60.61	56.98	58.30	49.55
10.0	90.5	1808	69.90	65.38	60.81	56.17	51.46	46.69	41.84
15.0	250.8	1304	66.46	59.13	51.71	44.20	36.59	28.88	21.07
18.0	611.6	900	58.72	45.04	31.22	17.25	3.11	-	-

Table 8

BOILER EFFICIENCY

Moisture % Bagasse = 60
Theoretical (no heat losses)

% Oxygen	% Excess Air	Temp. F Furnace	Flue Gas Temperature, deg. F 200	300	400	500	600	700	800
0.0	0.0	2378	-	67.30	64.26	61.18	58.05	54.86	51.62
5.0	31.0	2110	69.62	66.09	62.50	58.86	55.16	51.41	47.59
10.0	90.5	1759	68.34	63.76	59.12	54.42	49.64	44.80	39.88
15.0	250.8	1276	61.91	57.51	50.02	42.45	34.77	27.00	19.11
18.0	611.6	886	57.16	43.42	29.54	15.50	1.29	-	-

Table 9

BOILER EFFICIENCY

Moisture % Bagasse = 62
Theoretical (no heat losses)

% Oxygen	% Excess Air	Temp. F Furnace	Flue Gas Temperature, deg. F 200	300	400	500	600	700	800
0.0	0.0	2289	-	65.51	62.40	59.24	56.04	52.77	49.46
5.0	31.0	2038	67.90	64.30	60.64	56.93	53.15	49.32	45.43
10.0	90.5	1707	66.62	61.97	57.26	52.48	47.63	42.71	37.72
15.0	250.8	1246	63.18	55.72	48.16	40.51	32.76	24.91	16.95
18.0	611.6	871	55.54	41.63	27.37	13.56	-	-	-

Table 10

BOILER EFFICIENCY

Moisture % Bagasse = 64
Theoretical (no heat losses)

% Oxygen	% Excess Air	Temp. F Furnace	Flue Gas Temperature, deg. F 200	300	400	500	600	700	800
0.0	0.0	2194	-	63.52	60.33	57.09	53.80	50.46	47.05
5.0	31.0	1961	65.99	62.31	58.57	54.77	50.92	47.01	43.03
10.0	90.5	1650	64.71	59.98	55.19	50.33	45.40	40.40	35.32
15.0	250.8	1214	61.27	53.73	46.09	38.36	30.53	22.59	14.55
18.0	611.6	855	53.53	39.64	25.60	11.41	-	-	-

Figure 1

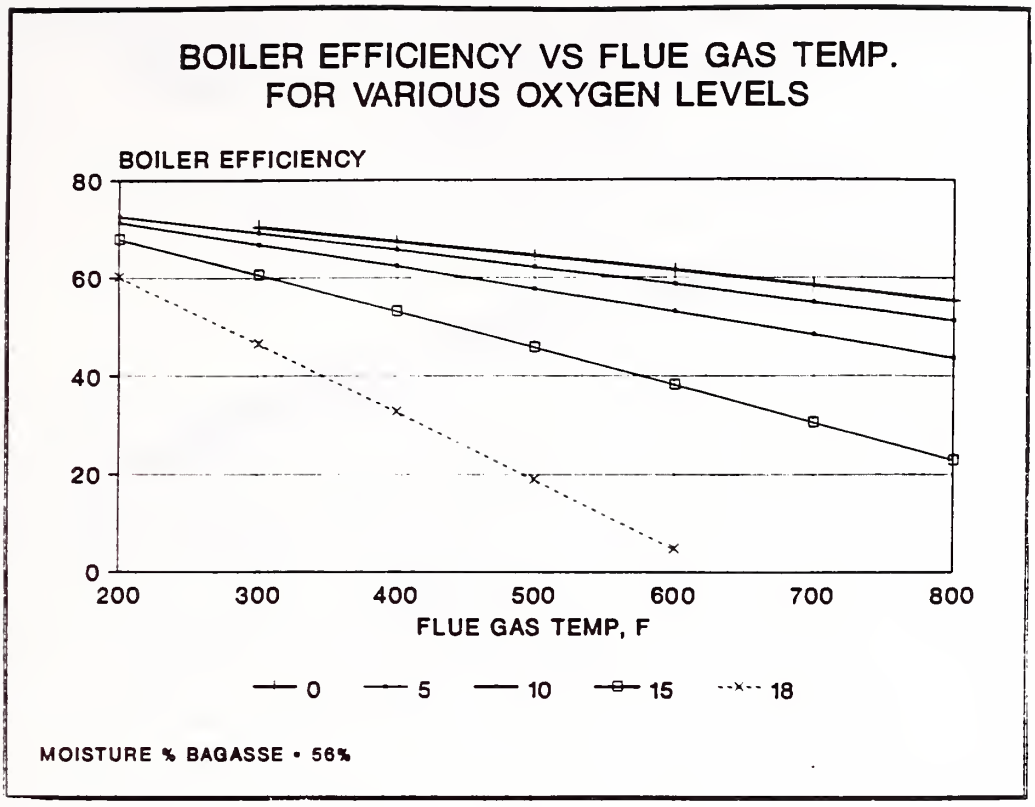


Figure 2

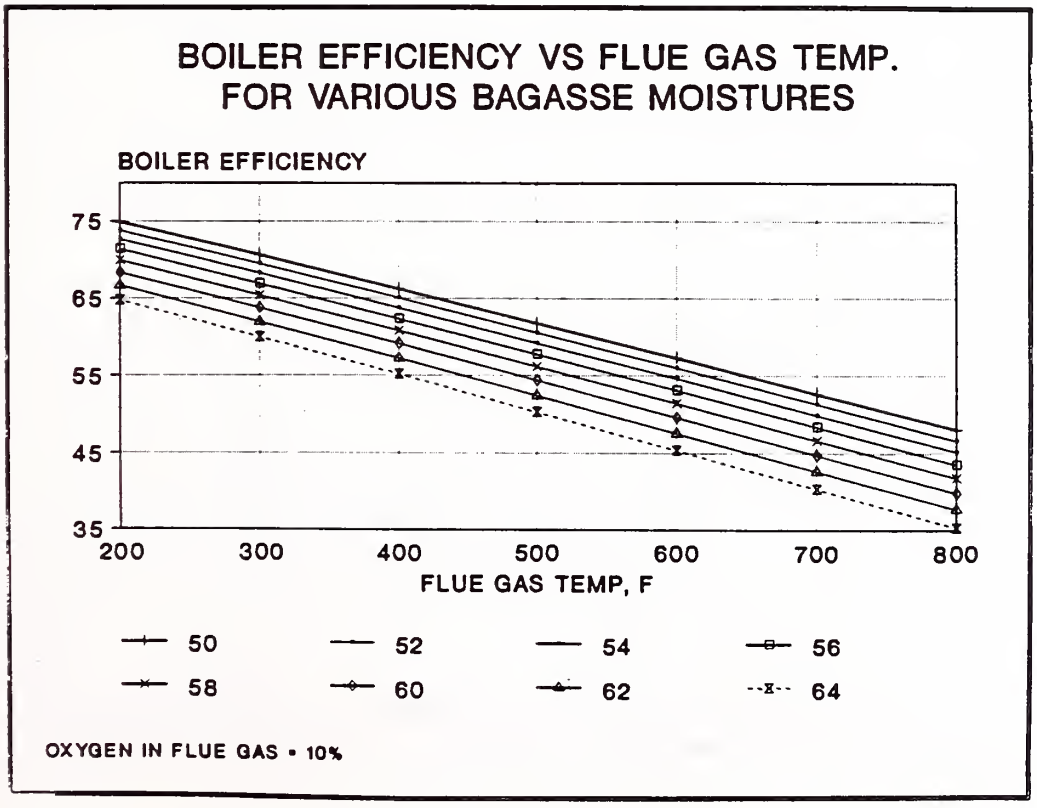


Figure 3

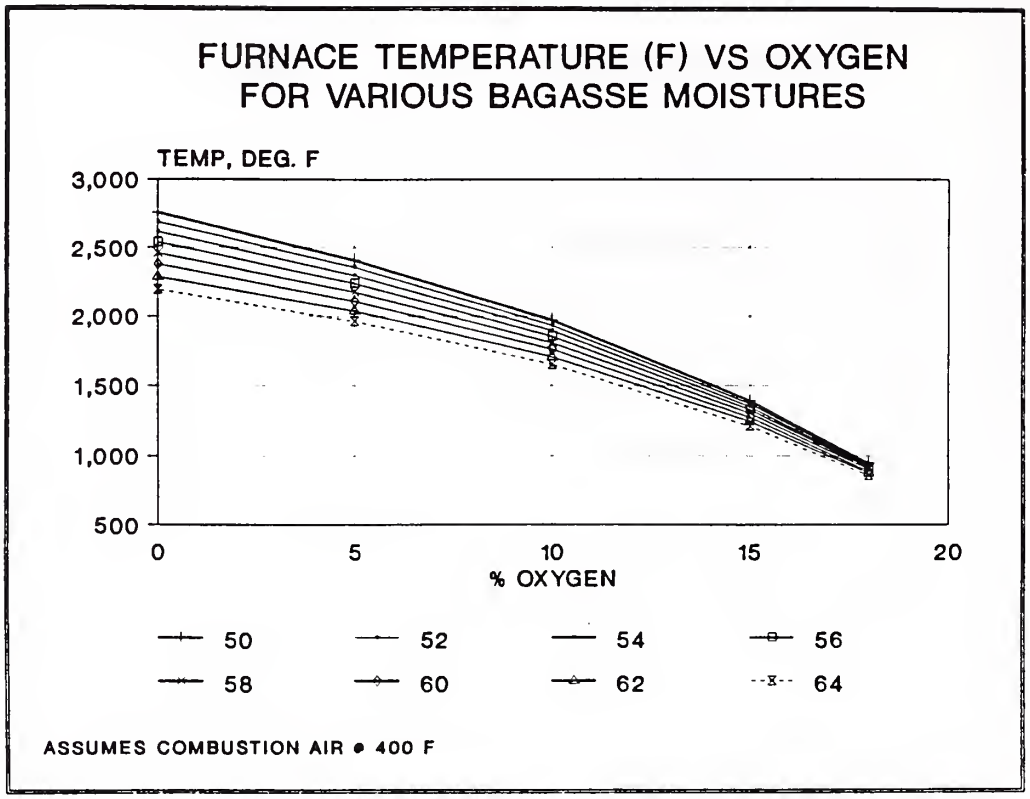
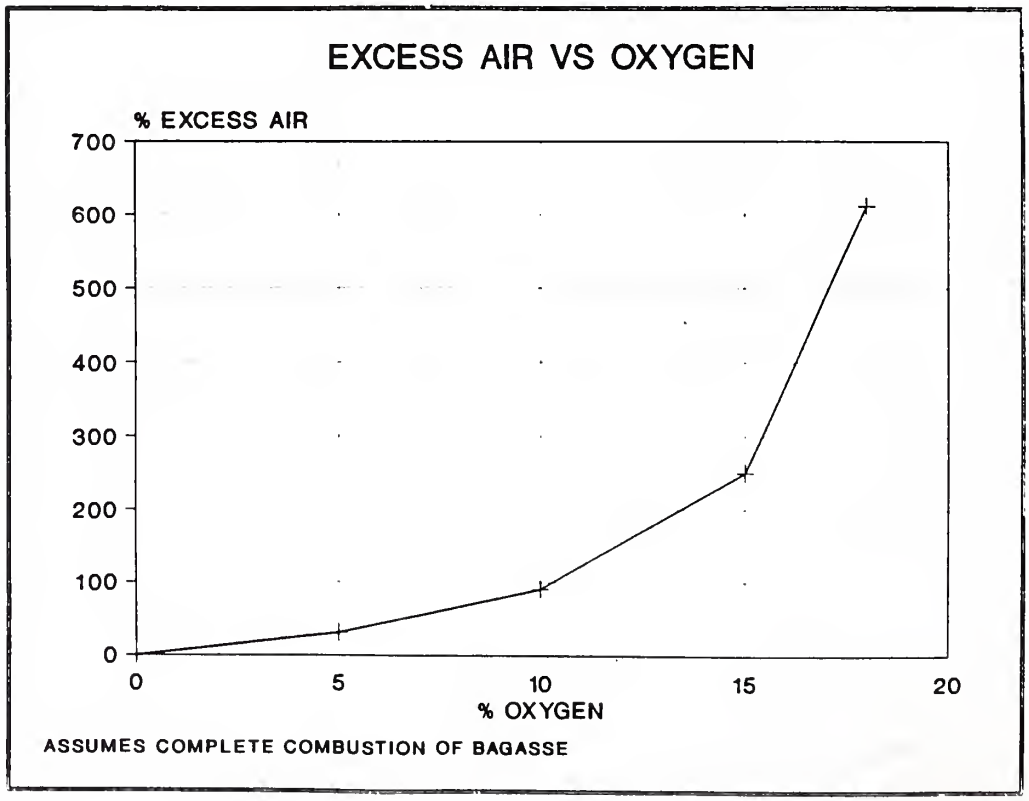


Figure 4



LOSSES ASSOCIATED WITH CANE YARD OPERATIONS AND CANE WASHING

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Abstract

In Louisiana all cane is mechanically harvested and loaded as the whole stalk. Cane delivery is by road and over an 9-10 hour period with some cane being sent directly to the mill tandem and the remainder being stored in the yard. All cane is washed extensively before entering the carrier. In an attempt to determine the losses involved, prepared cane was sampled as frequently as possible for extended periods (up to three days) and analyzed by the (core)-disintegrator-press system used for incoming cane. At the same time cane wash water was analyzed for sucrose by HPLC. These tests indicate higher than expected losses in this part of the factory and are being used to assess the feasibility of modifying the system.

The agricultural operations of the Louisiana sugarcane industry are now completely mechanized and this has a major impact upon the quality of cane delivered to the mill. Standard practice is to cut the cane unburnt with a whole stick soldier harvester and lay it across the row to form a heap-row from three or four rows of cane. This cane is burnt in the heap-row and then loaded onto wagons for transportation to a transloading station (where it is transferred to a truck) or directly to the mill. Under rainy conditions the cane cannot be burnt and is milled with the leaves and trash. Several systems for loading cane are used, but they all bring in more field soil than acceptable for process. Cane washing is necessary to minimize the process problems associated with high soil levels. It is not the purpose of this paper to discuss the specific impacts of trash and dirt on factory operations but rather to describe the impact of the unavoidable cane washing.

Upon receipt at the factory the cane is weighed and sampled by the core / press procedure (1). the percentage of loads analyzed varies quite widely, from almost 100% to as low as 30%. Cane is delivered to the factory for about ten to twelve hours per day and during this period some cane is unloaded directly into the carrier and the remainder unloaded into the yard where it is stacked for grinding overnight. Under normal conditions it is unusual for much cane to be left in the yard when deliveries begin the following day. Most factories use front-end loaders to move and stack the cane and this is a well known cause of damage to the cane and potential sugar loss. Some mills use the front-end loaders to supplement gantry or derrick systems but these were not part of the present study.

The work described in this paper is supported by the American Sugar Cane League and seeks to measure the magnitude of the losses incurred between delivery of the cane

and its entry to the extraction system. The cane handling system currently in use is recognized as being far from ideal but the cost of changing would be very high and would have to be justified by recovering additional sugar and/or by minimizing the other problems associated with the current cane handling system. Very large volumes of water are used in the cane washing systems and this water leaves the factory with a far higher b.o.d. than is acceptable for discharge into local rivers or lakes. Environmental regulations are becoming much stricter and it is no longer possible to ignore the loss of sugar in the water which has in the past usually been assumed to be negligible as far as the mill is concerned.

This study is an attempt to quantify the cane handling losses of sucrose so that mill management can make better decisions on how to improve the system. These losses can be thought of as chemical, due to deterioration of the cane during storage and due to damage during handling, or as physical, squeezing of the cane under the tires of the loaders or in the washing system. Ideally the experimental system should be able to distinguish between these two and between the losses on the yard and on the wash table. The approach taken was to use the same analytical procedure for the prepared cane entering the mill as is used for the cane analysis upon receipt at the mill. There are some inaccuracies inherent in the core / press system but these should at least partially balance each other and it should be possible to observe the changes in cane composition. other measurements were made directly on the sugar content of the water used in the wash system.

The press analysis allows determination of the percentages of pol (P), soluble juice solids (B) and "fibre" (F) in the cane. the assumption is made that the residual juice in the press cake has the same brix and purity as the expressed juice. This is not the case and the magnitude of the error introduced is largely dependent on the degree of preparation of the cane. The "fibre" in this case is the total insoluble solids, including field soil. The theoretically recoverable sugar (TRS, expressed as kg of sugar per Mg of cane) is calculated from these factors, using assumptions about average mill extraction and boiling house efficiencies, by the following equation -

$$TRS = (0.14*P - 0.04*B)*(100 - 56.67*F/(100-F))$$

The first part of the equation is a modification of the Winter-Carp formula and the second part relates the expected extraction to the fibre content.

In Louisiana the mixed juice is not usually weighed and, if it is, the accuracy is usually poor. For mill balance purposes the juice weight is estimated from sugar and molasses yields and composition and the cane composition calculated from the estimated juice quantity. This system tends to minimize the reported juice production, lowering the apparent mill extraction, and to increase the boiling house efficiency. There is a fairly good inverse correlation between the reported boiling house efficiency and the reported difference between pol % cane determined from the core laboratory and from the mill balance estimation. If the press system could be used to determine directly the prepared cane composition, this would be a useful check against the mill calculations.

Experimental Procedures

Prepared cane analyses were carried out at the mills using the same equipment and procedure as used for routine incoming cane quality determination. Any variations in procedure used by the factory laboratory staff were also used by Audubon Sugar Institute (ASI) personnel. In most cases the daytime samples of prepared cane were run by the factory personnel. The factory laboratory would usually perform 100 - 300 press analyses per day.

Dry lead subacetate was used as the clarification reagent for the 1989 tests and the new ABC reagent was used exclusively during the 1990 tests, by both the factory laboratory and ASI (2).

For the 1989 tests, samples of prepared cane were used in the press without further preparation except in some cases where parallel samples were run through the disintegrator system of the core sampler. For the 1990 tests a Reitz pre-breaker was modified and used with all samples of prepared cane to ensure more uniform preparation.

Runs usually began in the morning with the first delivery of cane onto the mill carrier and continued for at least 24 hours and in some cases up to 72 hours. Prepared cane was sampled as frequently as possible during this time, usually at intervals of about 20 minutes. All samples were analyzed immediately with no compositing. When water samples were taken from the wash table, the same sampling frequency was used.

Water samples were frozen in dry ice for storage until run on a Dionex Ion Chromatograph to determine sucrose, glucose and fructose. No dilution of the samples was necessary and the only pretreatment was filtration using a 0.45 micron syringe filter. With standards the relative standard deviations were 3% for sucrose (at 600 ppm) and 10% for glucose and fructose (at 30 ppm).

Results and Discussion

1. Comparison of Prepared Cane Composition with Incoming Cane Composition.

Five runs at three mills were carried out during the 1989 season and eight runs at three mills during the 1990 season. Except when mill stoppages occurred sample were taken and analyzed continuously. The results of a 72 hour test in the 1989 season are shown in Figure 1. The test began at 6 a.m. and there is a distinct difference between the TRS values obtained during the day (cane being delivered directly onto the wash table) and during the night (cane taken from the yard). The difference in predicted recoverable sugar per Mg of cane is at least 5 kg. Similar results, but with varying differences between day and night, were observed for all the tests during 1989. However, the tests performed during the 1990 season did not show this characteristic feature and Figure 2(B) is more typical of the results obtained.

In some cases there was a higher average TRS for prepared cane during the day and in other cases no difference, or even a small increase was observed during the night. In 1989 the observed difference was initially attributed to cane deterioration but conditions were similar in 1990 and the difference was not observed. The alternative possibility is that the difference is due to sampling and/or analysis procedure changes that were made for the 1990 crop. These changes involved both the sample preparation and the reagent used for polarization measurements.

In 1989 samples of prepared cane were run through the pre-breaker of the core sampler whenever this was possible. This was not possible at night. To check the effect of the additional preparation on the TRS values obtained, some samples were divided and pressed with and without the use of additional preparation. The results of these tests are shown in Figure 3; the average increase in the TRS is about 3 kg/Mg for the extra prepared cane.

The other factor is the use of the ABC clarification reagent. Although use of this reagent usually results in a slightly lower value (by 0.2 - 0.4) for the polariscope reading than with dry lead subacetate, the reagent quantity does not significantly affect the reading. However, increasing the quantity of lead subacetate results in a marked increase in the reading. In 1989 the factory laboratory staff performed the day-time analyses and ASI staff the night-time analyses. It was observed that some mill personnel tended to be quite liberal in the use of lead subacetate whereas the ASI technicians consistently used less. In the tests of the new reagent system it was observed that excessive use of lead subacetate could increase the polariscope reading by up to 2 points. Calculation of the consequential increase in TRS shows it to be up to 4 kg/Mg. Combining these two factors negates the observation in 1989 of a large day to night difference in cane quality.

The other, and more important, difference is between the delivered (incoming) cane and the prepared cane. All the data for both are plotted in Figure 2; Figure 2(A) shows the spread of TRS values for incoming cane and this is very much larger than for the prepared cane. Histograms to show the distribution of TRS values for all this data are shown in Figure 4. In this case, both the incoming and prepared cane show a close to normal distribution, but wide variations from normal distributions are observed, especially at one mill, shown in Figure 5. Laboratory practices play a part in this difference and this is a matter for further investigation. The values for the mean and standard deviations for the TRS values for incoming and prepared cane for all the tests performed in 1990 are given in Table 1.

Inspection of this data indicates that there is no difference between the quality of the incoming cane and the prepared cane as determined by the TRS value. This conclusion is confirmed by application of standard statistical tests. The higher TRS values for prepared cane and high deviations and the second mill is almost certainly influenced by their laboratory procedures.

One of the problems with this approach is that the TRS is a derived value and can be influenced by fairly small variations in the input data. For example, if cane of

composition (P=12.0, B=14.1 and F=15.0), in which the true fibre is 12.5% with 2.5% field soil on cane, is washed without loss of juice solids to give composition (P=12.0, B=14.1 and F=12.5, with water making up the difference), the TRS increases from 100.4 to 102.6 kg/Mg.

It may be more reasonable to consider the actual values obtained for the pol, brix and fibre % cane and, for the tests at Raceland where the most complete data was obtained, the composition of incoming and prepared cane, as well as from the factory report, are given in Table 2. It is therefore possible to make some estimate of the factors involved in the change in cane composition due to cane yard operations and cane washing. The factors include -

1. The loss of sucrose by inversion - this is neglected in this case since the purity changes are small;
2. Loss of juice solids by leaching;
3. Removal of field soil - measured in the system as "fibre";
4. Addition of water to the cane.

Since there are only two data points (brix % cane and fibre % cane) for the samples, it is not possible to obtain a specific value for each factor. However, if the quantity of water is assumed, the effects of the other factors can be calculated and the results are shown in Figure 6. Given the data on the direct measurement of sucrose lost in the wash system (see the next section), the most reasonable values are 2 - 4% loss of juice solids, 10 - 15% loss of "fibre" and an increase in cane weight of 3 - 5%. These results are in agreement with previously determined values, e.g., for loss of field soil.

It should also be noted from Table 2 that the pol % cane reported by the factory is significantly less than that determined by direct analysis. Furthermore, the delivered cane weight is used as the milled cane weight, ignoring the increase in cane due to water. For the data on prepared cane composition reported here, the decrease in pol % cane is somewhat offset by the increase in cane weight.

2. Sugar Losses in Wash Water.

Only one extended determination of sugar levels in cane wash water was made in 1990, but the results were similar to those obtained the previous year. The sucrose content of the wash water over a 72 hour period is shown in Figure 7. No periodicity is shown in the data, especially for the net change in sucrose concentration (Figure 7(C)). The net water flow through the system is 35 m3/minute, and with an average sucrose concentration increase of 94 ppm, this amounts to about 3 kg of sucrose per minute. At the grinding rate of 5 Mg cane/minute this gives 0.6 kg sucrose lost per Mg cane. Similar and higher values (up to 2.5 kg/Mg) were obtained the previous year.

The most disturbing conclusion from this data is that the sucrose level in the wash table make-up water is very high, averaging 304 ppm sucrose. Condenser water is used

as the make-up and flow at a total rate of 80 m3/minute, with only part being sent to the wash table. This is a much more serious loss of sucrose than the wash table and is more easily remedied.

Figure 8 shows the level of invert in and out of the wash table and in this case there is a definite increase when cane is being taken from the yard. The damage to the cane and storage time are the cause and the average level of invert lost is similar to that for sucrose at about 100 ppm. Figure 8(b) confirms that the source of invert is the wash table. For this case, from the wash table alone, the load on the environment is at least one kg of b.o.d. per Mg of cane ground. If the condenser water is taken into account, the total load is much higher. These data are in line with other published data from a wide variety of sources.

A specific example of the sucrose loss in cane washing, measured in 1989 is -

To the wash table:
19 m3/min fresh water
34 m3/min from pond with 420 ppm sucrose
= 14.3 kg sucrose / min.
From the wash table
53 m3/min with 460 ppm sucrose
= 24.4 kg sucrose / min.
Difference of 10.1 kg sucrose / min.; at 3.5 Mg cane per minute (5,000 Mg/day).
Loss per Mg cane = 2.9 kg.

Conclusions

The utility of the press system for comparison of the composition of prepared cane with that of both delivered cane and factory reported cane is demonstrated. The use of derived cane quality parameters for estimation of sugar losses is of doubtful validity. Considerable care must be exercised in setting up the experimental procedures.

From both the cane composition data and the directly determined sucrose losses at the wash table, the loss of sucrose in handling and washing is in the range of 1 - 2% of the sucrose in the incoming cane, and is on occasion higher. HPLC or ion chromatography are ideal systems for determination of the magnitude of these losses.

References

1. "Observations on the Louisiana Core Samplers"; Harold S. Birkett, J. Amer. Soc. Sugar Cane Tech. 1979, 93-95.

2. "A Simple and Safe Replacement for Dry Lead Subacetate"; Stephen J. Clarke and Joy Bourgeois, Int. Sugar. J., 92, 35 (1990)

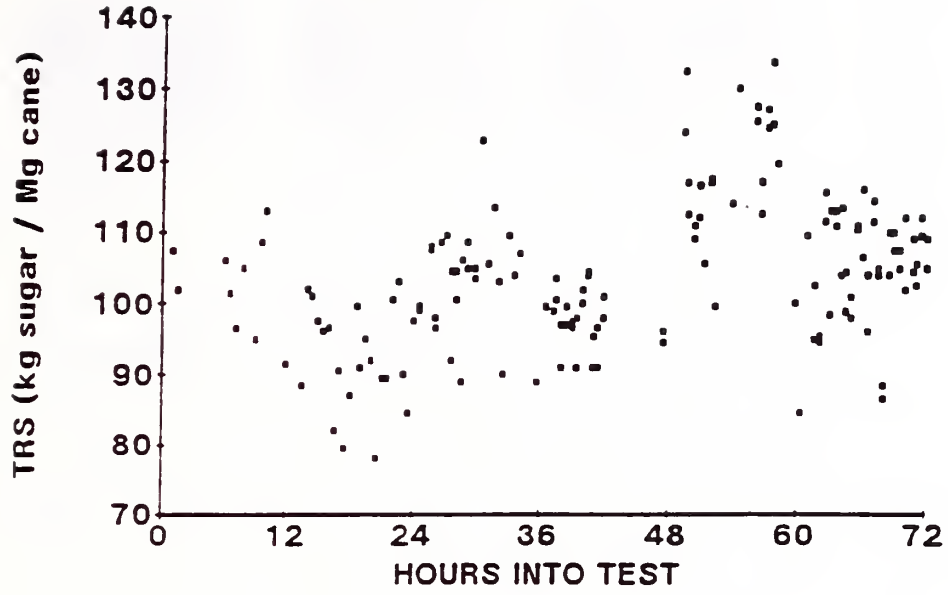

Figure 1.

TRS of prepared cane during 72 hour test at St. Mary Sugar Cooperative. Gaps in data are due to short mill stoppages. Some duplicate samples are included.

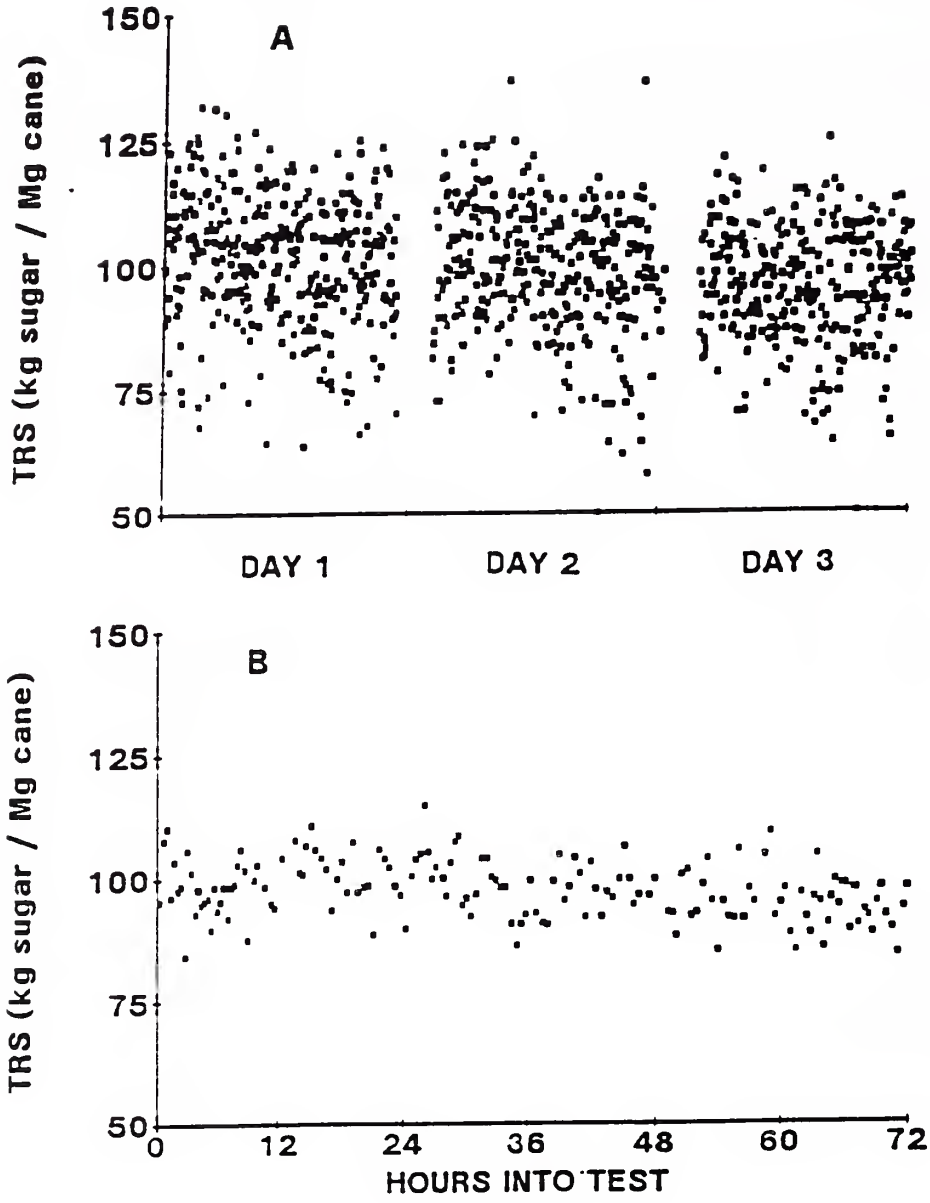

Figure 2.

A. TRS values of incoming cane sampled during the 72 hours of the test at Raceland Factory. All data plotted in order of receipt of samples with days separated.

B. TRS values of prepared cane during the same test.

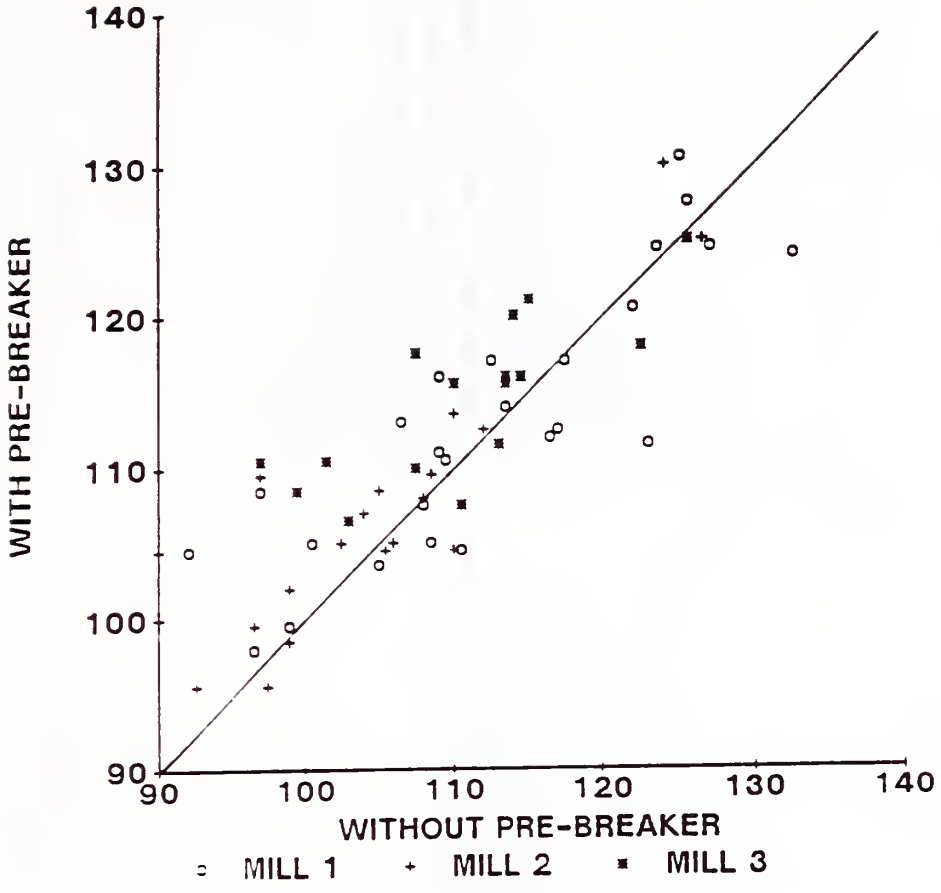

Figure 3.

TRS values for prepared cane samples with and without additional preparation. The diagonal line represents the ideal case of no difference between samples. Note the results from Mills 1 and 2 fit better than for Mill 3, at which the preparation was relatively poor.

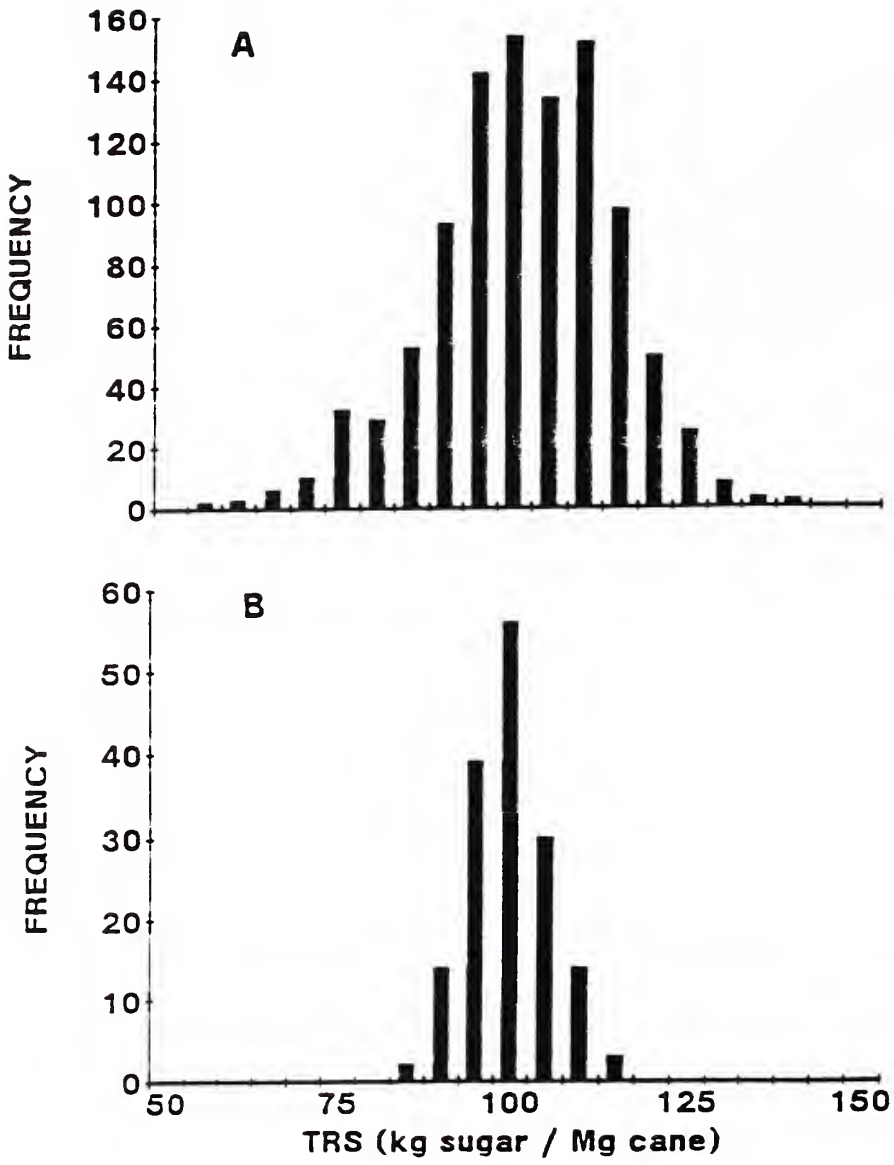

Figure 4.

A. Distribution of TRS values for incoming cane for a 72 hour period at Racelend Factory.

B. Distribution of TRS values for prepared cane during the same test.

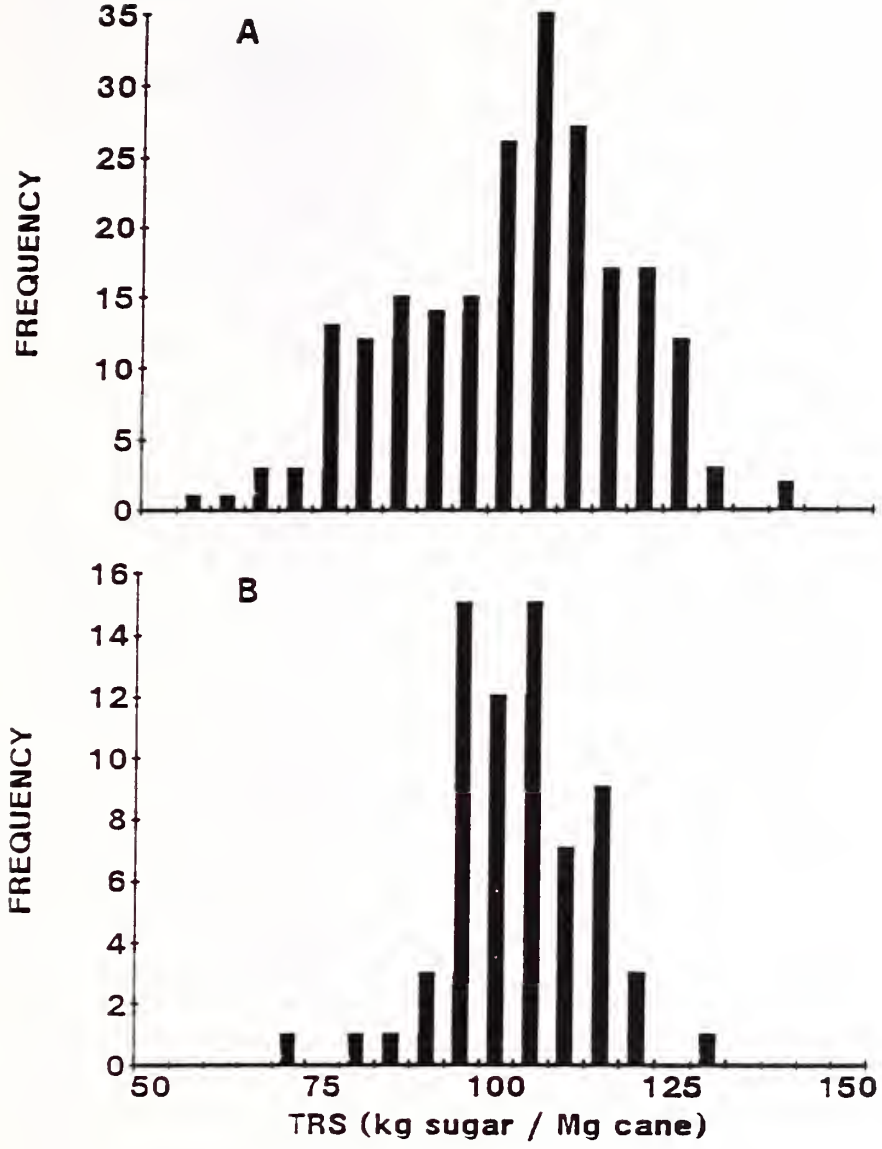

Figure 5.

A. Distribution of TRS values for incoming cane for a 24 hour period at Enterprise Factory.

B. Distribution of TRS values for prepared cane during the same test.

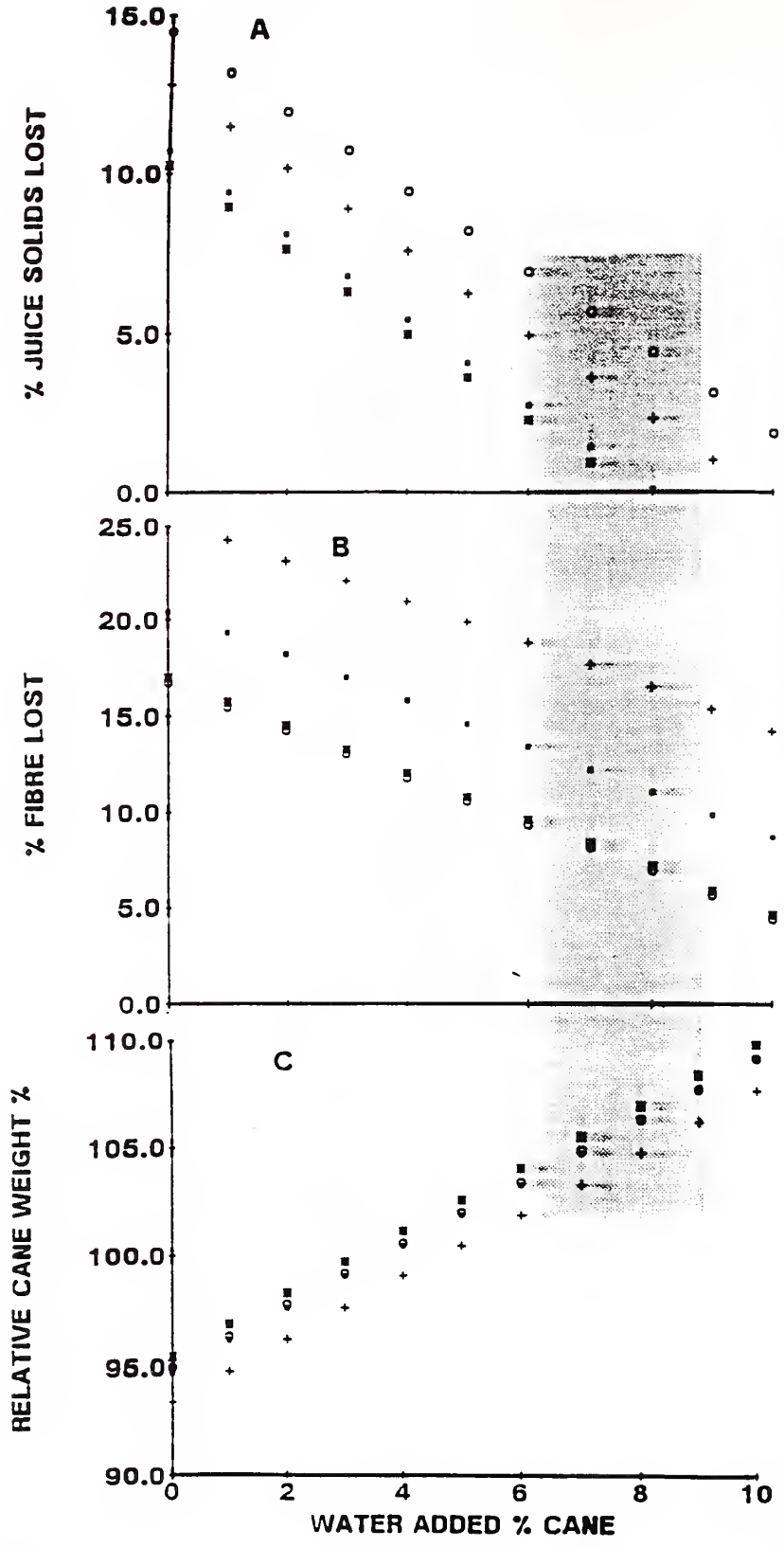

Figure 6.

Each graph shows the calculations for the three 1990 RaceInd tests and one from 1989. For an assumed quantity of water added to the cane, to achieve the desired change in cane composition, the loss of juice solids (A), loss of "fibre" (B) and gain in cane weight (C) are calculated. The shaded area corresponds to the most reasonable set of conditions.

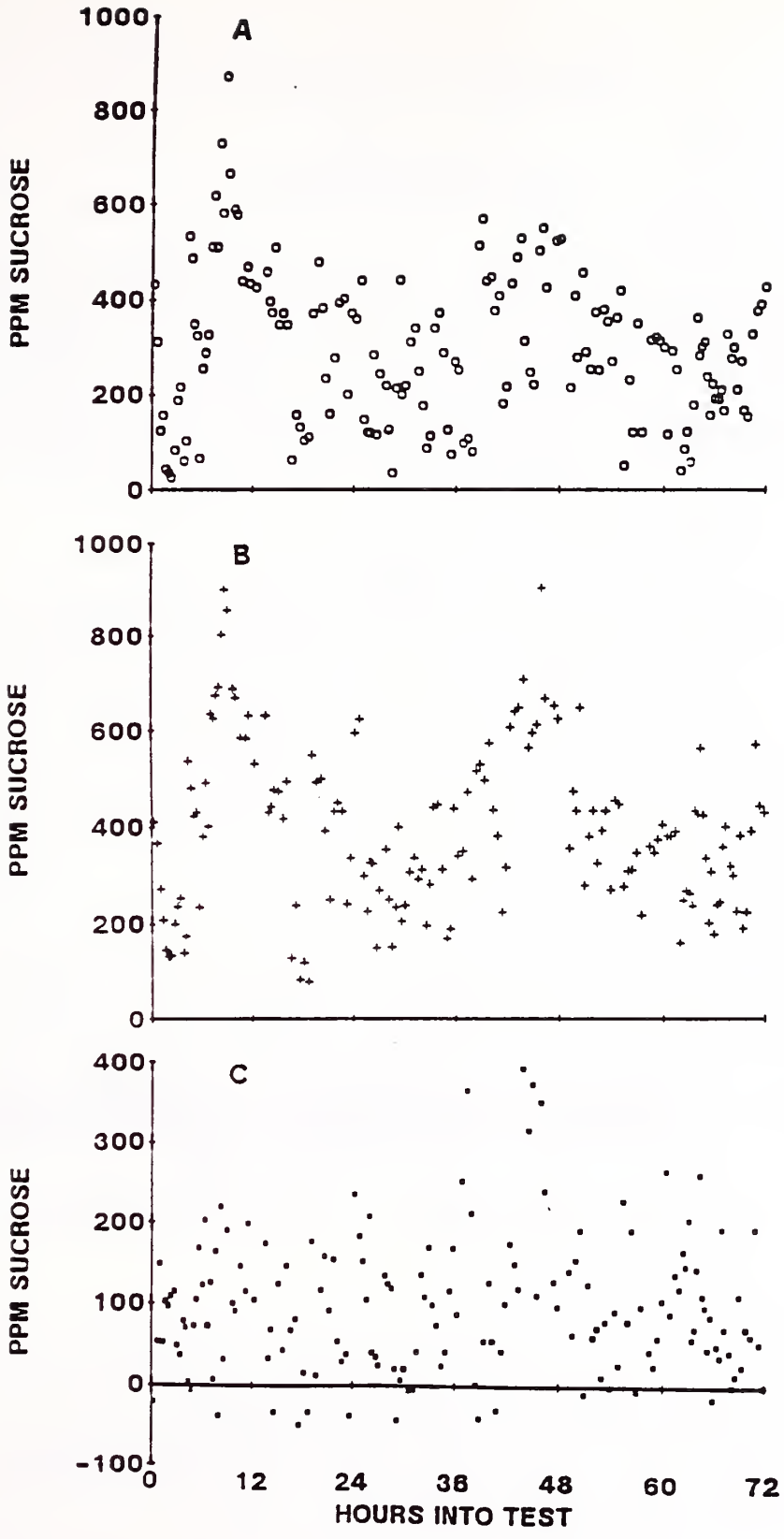

Figure 7.

Variation with time of the sucrose levels in make-up water going to the wash table (A), water leaving the system (B) and the net sucrose concentration increase (C).

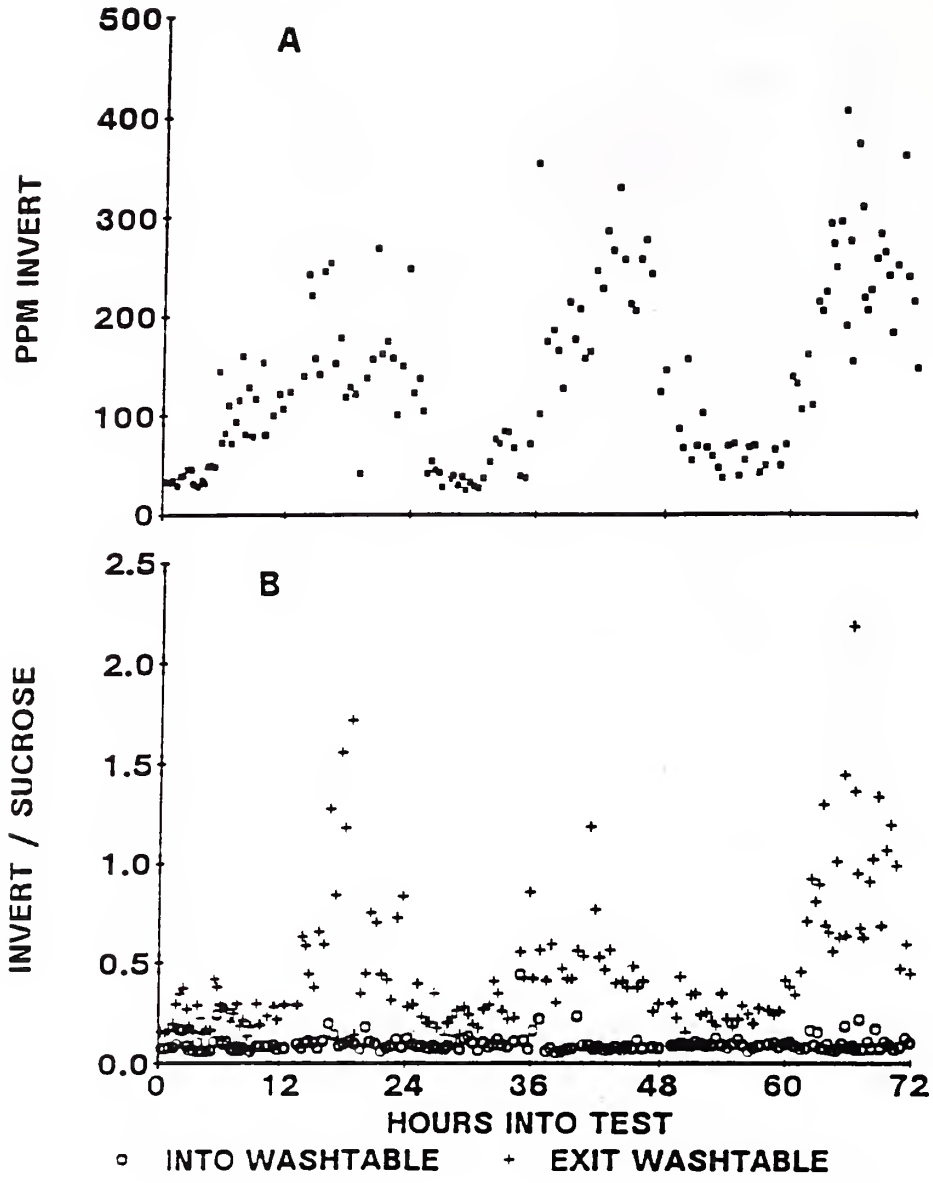

Figure 8.

A. Net concentrations of invert in the water leaving the wash system over the time of the test.

B. Invert / sucrose ratios for samples entering and leaving the wash system.

MICROBIOLOGY RESEARCH

Donal F. Day
Audubon Sugar Institute

This research program concentrates on developing production systems for two different biological polymers with existing markets; dextran and alginic acid. The concept is to supply the Louisiana sugar producers with alternate products and markets for sugar and sugar by-products. This research is following two distinct avenues. The goals in both cases are to produce bio-polymers with a wide range of applications using conditions and technologies that are readily adaptable to existing facilities at raw sugar mills. The two unrelated polymers that are being researched are dextran and alginate(s).

Dextran

This polymer is a mono-glucan. It is commercially produced on white sugar and yeast extraction by fermentation with Leuconostoc mesenteriodes. The major market is for defined size dextrans, specifically for use in photographic emulsions and as blood plasma extenders. The existing process has several disadvantages; low dextransucrase productivity by cells, relatively low yields throughout the whole process of dextran synthesis, high cost of alcoholic precipitation and a major expense in hydrolysis and separation of the low size dextrans.

Recent Progress:

We have developed a method for controlling the size of the dextran molecules produced during the fermentation of L. mesenteroides on sucrose through use of a unique mixed culture fermentation process. This process also has the advantage of a 50% increase in product yield. The hydrolysis step is no longer separated from the production step in this process. A patent application has been submitted. We have also significantly reduced the costs of the standard methods of production by substitution of raw sugar and molasses in the fermentation broths. This can provide an industrial, non-consumption, market for raw sugar.

Alginate

Alginate is a polyuronic acid polymer characterized by its ability for form gels in the presence of selected sales. It is one of the few eucaryotic polymers that can be produced by bacterial fermentation. Currently, all commercial alginate is produced from seaweed. However, at least half the world's sources are at risk due to pollution and/or political instability. It is proposed to develop an industrial production system for this precursor by fermentation of sucrose using Pseudomonas syringae and then to modify the product enzymatically to produce high quality, defined polymers.

Precursor production

We have defined the fermentation system for the production of acetylated polymannuronic acid and a procedure for deacetylating this polymer. Research is proceeding on the optimization of the fermentation for PMA (poly-mannuronic acid).

Polymer modification

Two different modifications are possible to this polymer, an epimerization and an acetylation. We have been able to acetylate both poly-mannuronic acid and commercial (seaweed) alginate using a selected immobilized cell system. Acetylation of commercial alginate has not previously been reported. Currently we are investigating the changes in properties this substitution has on the polymer.

Project Overview

The development and demonstration of new technology to produce well defined biopolymers from sugarcane can enhance the economic base of the traditional sugar processing industry in Louisiana. The production process for controlled size dextrans is well developed and commercial interest has already been expressed. This technology is readily adapted to a local factory if there is an interest.

The alginate research is not yet ready for commercial application. As it matures, however, it will offer the ability to produce a set of polymers with a wide range of physical properties. These can be custom applied to any particular application.

1990 SUGARCANE WASH WATER PROJECT SUMMARY

Curtis Sutherland
Sugar Station/Audubon Sugar Institute

Introduction

Water and air quality standards for the Louisiana Sugar Industry have become more stringent and are being readily inforced as the concern of "environmental impact" becomes more focused. This project addressed several water quality and management issues. Some of these issues are:

1) the ability to meet factory discharge limits set by the Louisiana Department of Environmental Quality (LDEQ), (i.e. Biochemical Oxygen Demand (BOD), Total Suspended Solids (TSS), pH, Dissolved Oxygen (DO) requirements);

2) the odor control for the aesthetic value of the encroaching city suburbs;

3) the pH control to minimize the detrimental effects of corrosion on factory equipment thereby minimizing cost;

4) the determination of sugar losses into the wash-water due to cane washing;

5) to reduce water usage, thereby minimizing the cost of water treatment systems;

6) and to determine common criteria that can be used in the design of lagooning treatment systems for all Louisiana sugar factories.

Addressing all of the previous issues, in conjunction with each other, will result in the optimum water usage for the Louisiana sugar factories. This corresponds to greater efficiency and thereby maintains profitability.

Background

During the 1989 season an extensive effort was done to collect as much water quality data as possible on a newly constructed wash water lagoon system at the Leighton Mill. This effort was used to identity and quantify the existing lagoon condidtions and to identify problem area and solutions. Several examples of these would include; 1) maximum and/or minimum BOD's, COD's, TSS, pH, & DO; 2) the minimum aeration required to maintain a DO greater than 1.0 mg/L; 3) the lime requirements needed to neutralize the intermediate acids formed by anaerobic biodegratation of sugar; 3) the minimum water usage during pan washouts; 4) and collection and treatment of all sugar mill run off waters.

Recent Progress

The 1989 project was followed by collecting data at the same lagoon system during the 1990 season while also collecting water quality data from the Caldwell Mill wash pond. This allowed the comparison of the 1989 water quality data to the 1990 data along with the comparison of two individual washing systems.

In addition to the wash pond data, the wash-table effluent flow at twelve additional factories was collected. This data gives insight into the water quality ranges while also becoming a good beginning point for the standardization of waste-water management practices within the Louisiana Sugar Cane Industry.

The 1990 data are presented (see appendix) in tabulated and graphical forms. The ranges of water quality parameters on December 7, 1990 are as follows:

pH	3.8 - 11.5
DO	3.3 - 9.3 mg/L
BOD5	1,040 - 5,749 mg/L
COD	1,375 - 5,667 mg/L
BOD5/COD RATIO	0.8 - 1.0
TSS	1375 - 3,945 mg/L
TDS	181 - 1,580 mg/L
TVSS	62 - 590 mg/L
H2O	13.9 - 29.1 oC

***Note:** These are not necessarily the highs or lows for the 1990 season.

In addition to the newly collected data, the wash-water BOD data has been analyzed for reaction rate coefficients (k). This coefficient is a must in the evaluation and design of treatment systems. It reveals the speed at which the micro-organismmms consume or convert the sugar waste to cell energy and mass (i.e. biodegradation rate).

The preliminary first order non-linear least squares and gradient search models shows a coefficient range of 0.4 to 1.1 days-1 for the Leighton effluent and a range of 0.3 days-1 for the influent. These k values will be compared to 1/2 and 3/2 order reaction rates, to confirm the most appropriate model for sugar waste.

WASH WATER PROJECT

11/30/90

Sugar Mills	pH	DO	BOD5	COD	BOD5/ COD	TSS	TVSS	TDS	Air Temp	H20 Temp
1	5.9	1.1	920	1151	0.8	334	194	610	7.7	16.9
2	6.4	0.2	740	835	0.9	702	165	380	21.1	34.0
3	7.4	4.3	500	886.5	0.6	493	88	350	18.3	34.6
4	5.2	0.4	1560	1560.0	1.0	1274	273	550	13.3	16.5
5	10.6	7.8	2300	2924	0.8	173	57	1230	7.2	15.9
6	7.3	0.2	470	555	0.8	1180	143	240	16.7	27.1
7	7.2	8.0	533	1348	0.4	5190	387	180	18.3	13.3

WASH WATER PROJECT

12/07/90

Sugar Mills	pH	DO	BOD5	COD	BOD5 /COD	TSS	TVSS	TDS	Air Temp	H20 Temp
1	4.0	6.7	5749	5667	1.0	785	270	750	13.5	23.5
2	6.8	3.3	1040	1375	0.8	306	190	570	10.0	14.1
3	8.6	9.3	5520	5022	1.1	925	370	181	13.8	15.5
4	3.8	5.4	4520	4371	1.0	2675	590	750	14.3	27.7
5	11.5	8.4	3140	3198	1.0	138	62	1580	10.0	13.9
6	6.5	4.5	3720	3316	1.1	2235	300	870	15.7	21.9
7	6.0	6.5	1750	1750.0	1.0	1238	250	290	13.2	29.1
8	6.9	7.1	1600	1666	1.0	3945	565	260	14.7	23.4

LEIGHTON MILL

Location 1 (Influent)

DATE	pH	DO	BOD5	COD	BOD5/COD	TSS	TVSS	TDS	Tem Air	Temp H20
10/19/90	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
10/26/90	8.3	9.7	142	515	0.3	1025	160	260	#N/A	#N/A
11/02/90	8.9	1.7	414	846	0.5	405	125	320	27.1	19.5
11/09/90	11.3	6.8	780	1416	0.6	99	41	770	16.8	18.1
11/16/90	11.3	5.2	1470	1942	0.8	70	34	850	21.8	19.0
11/23/90	11.4	3.6	1900	2746	0.7	90	51	1040	#N/A	#N/A
11/30/90	10.6	7.8	2300	2924	0.8	173	57	1230	7.2	15.9
12/07/90	11.5	8.4	3140	3198	1.0	138	62	1580	10.0	13.9
12/14/90	11.6	8.9	3080	3692	0.8	233	57	1610	20.0	16.4

Location 5 (Effluent)

Date	pH	DO	BOD5	COD	BOD5/COD	TSS	TVSS	TDS	Temp Air	Temp H2O
10/19/90	8.2	4.6	11	80	0.1	15	2	300	#N/A	#N/A
10/26/90	8.7	9.9	11	74	0.1	28	22	250	#N/A	#N/A
11/02/90	6.2	0.9	326	578	0.6	110	41	290	27.1	19.5
11/09/90	5.7	1.6	610	1048	0.6	65	36	520	16.8	18.0
11/16/90	6.6	1.7	1365	1546	0.9	45	32	700	21.8	19.7
11/23/90	6.0	0.7	1747	2413	0.7	52	49	890	#N/A	#N/A
11/30/90	5.8	1.8	2100	2592	0.8	77	59	1090	7.2	17.0
12/07/90	6.6	7.0	3180	2901	1.1	98	65	1120	10.0	14.0
12/14/90	6.3	1.5	3340	3675	0.9	84	78	1180	20.0	15.2

CALDWELL MILL
Pond Mid pt.

Date	pH	DO	BOD5	COD	BOD5/ COD	TSS	TVSS	TDS	Temp Air	Temp H2O
10/19/90	7.8	6.9	6	102	0.1	139	120	300	#N/A	#N/A
10/26/90	8.1	9.2	5	88	0.1	26	23	420	#N/A	#N/A
11/02/90	6.4	1.7	244	491	0.5	82	33	350	20.8	18.3
11/09/90	6.5	1.0	330	634	0.5	165	61	450	17.8	18.0
11/16/90	6.1	0.8	620	766	0.8	185	84	470	21.6	18.2
11/23/90	6.3	0.2	820	1147	0.7	177	119	540	#N/A	#N/A
11/30/90	5.9	1.1	920	1151	0.8	334	194	610	7.7	16.9
12/07/90	6.8	3.3	1040	1375	0.8	306	190	570	10.0	14.1
12/14/90	5.6	0.9	1880	1714	1.1	592	356	600	20.0	15.8

Cooling (Spray) Pond

Date	pH	DO	BOD5	COD	BOD5/ COD	TSS	TVSS	TDS	Temp Air	Temp H20
11/23/90	7.8	0.1	330	269	1.2	127	105	#N/A	#N/A	#N/A
12/14/91	7.4	3.5	700	#N/A	#N/A	76	72	590	20.2	29.6

Holding Pond

Date	pH	DO	BOD5	COD	BOD/ COD	TSS	TVSS	TDS	Temp Air	Temp H20
11/16/90	7.2	0.7	700	577	1.2	76	68	550	#N/A	#N/A

RACELAND MILL

Wash Table

Date	pH	DO	BOD5	COD	BOD5/ COD	TSS	TVSS	TDS	Air Temp	H20 Temp
12/21/90	6.5	#N/A	1130	2373	0.5	9710	913	#n/A	#N/A	#N/A

Condenser Water

Date	pH	DO	BOD5	COD	BOD5/ COD	TSS	TVSS	TDS	Temp Air	H20 Temp
12/21/90	6.7	#N/A	900	1113.3	0.8	31	25	#N/A	#N/A	#N/A

Production of an Organic Fertilizer by Ammoniation of Filter Mud

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Summary

The objective of this project is to develop a process of ammoniating filtercake to produce a new type of slow-release, organically-based N fertilizer suitable for the turfgrass, home lawn and other speciality markets. During the past year we constructed a small-scale reactor that allows control of temperature, pressure, NH_3 and O_2 concentrations, and other variables. With this reactor we have successfully identified important factors influencing the amount of N that can be fixed by ammoniation. Using a poor quality filtercake (51% organic, 49% mineral matter, and 0.6-0.8% N) we can now consistently produce a fertilizer containing 5-6% N. When filtercake contains less mineral matter (soil), the N content of the final product is greater. Fractionation of the N in the final product shows that 70-80% of the N is in non-soluble organic forms, 20-28% in water-soluble forms and a small fraction (<5%) as ammonium and nitrate. These fractions should provide continual slow release of plant available N throughout the growing season. The N fertilizer produced has a pleasant odor, organic appearance, low heavy metal content and is free of pathogens and viable weed seed.

Background

There is a critical need for economical, environmentally sound disposal of filtercake produced during the milling of sugar cane. The high organic matter content of this material suggests that it may have value as a soil amendment, but the strong odor, high moisture and low nutrient content, and potential weed control problems make farm application of this material unattractive.

Increasing the N analysis and reducing the moisture content of this material would greatly enhance its value as a fertilizer for surface application on turfgrass or crops where use inorganic N fertilizers are inefficient and cause a number of management problems. Reaction of anhydrous ammonia with the organic matter in filter cake has potential for creating a highly desirable form of organically-based N fertilizer.

There is a rapidly growing market for organic fertilizers among golf course operators, homeowners and others because they provide slow release of N, avoid rank growth, and do not "burn" turf or other plants. Users of organic fertilizers made from municipal or agricultural wastes are concerned, however, that these products may contain pathogenic microorganisms, high concentrations of heavy metals, or produce offensive odors. Ammoniated filtercake would not share these problems and would contain higher N analysis, reduced shipping costs because of lower moisture content, and possess very desirable physical qualities (neutral pH, high organic content, attractive appearance).

Methodology

Experiments were initially performed in a 20L pressurized vessel placed in laboratory oven. Studies with this reactor showed that temperature, O_2, and organic C content were the

principal factors limiting the amount of N that could be fixed by injection of anhydrous ammonia. However, this sealed reactor approach had limited possibilities for commercial operation because it produced considerable amounts of unreacted NH_3.

A flow-through reactor was designed and constructed using a stainless steel column that allowed mixtures of NH_3 and O_2 to pass through filtermud. The outlet from this column was connected to a second column packed with filtercake that served as a scrubber for unreacted NH_3. This reactor provided precise control of temperature, pressure, and the ratio of NH_3:O_2 and produced small (5 g oven-dry wt) samples. Temperature was controlled within the column by wrapping the column with an insulated heating tape and a thermocouple. These devices were connected to a solid-state temperature controller. The mixture of NH_3 and air or O_2 within the column was controlled by pressure regulators on the supply cylinders of these gases. Pressure within the column was monitored by a gauge fitted at the outlet cut-off valve.

Experiments were performed to determine the optimum combination of temperature, pressure, reaction time and NH_3:O_2 ratio for increasing the N content of filtercake. After each experimental run, the ammoniated material was purged with air to remove all free ammonia and the material removed for N analysis. The total N content, amount of water-soluble organic N, and amount of extractable inorganic N were determined for each sample.

Findings

The amount of N fixed by filter cake increased as the temperature within the reactor was increased from 25 to 180°C. Material reacted above 180°C became blackened and developed an offensive odor, therefore 180°C was taken as the optimum temperature.

Experiments using various ratios of NH_3:air or NH_3:O_2 indicated that the optimum ratio was 1 part NH_3 to 4 parts O_2 supplied as purified O_2 or as air (20% O_2).

The amount of N fixed increased in response to increased pressure within the reactor. At pressures of less than 100 psi, use of purified O_2 resulted in greater ammoniation than did use of compressed air. At these pressures, the maximum amount of N fixed was only 3.5% in filtercake containing about 50% organic matter and 50% soil. As much as 7% N could be fixed in composted filtercake containing 80% organic matter.

The reactor was redesigned to maintain high pressures (2000 psi). As a point of reference, a cylinder of breathing air holds up to 3000 psi. Increasing pressure within the reactor to 1000 psi greatly increased fixation. No additional benefit was found in increasing pressures above 1000 psi. When the reactor was maintained at 1000 psi, mixing 1 part NH_3 to 9 parts air was as effective as mixing NH_3 with pure O_2. Eliminating the need for purified O_2 greatly simplified the process.

Experiments using various amendments such as sugar, bagasse, liquid NH_4OH, and catalysts were not successful in increasing ammoniation.

Preliminary experiments to ammoniate bagasse were not successful because this material "burned" at temperatures as low as 120°C.

Our past year's research has defined optimum conditions for ammoniation of filtercake. These conditions produce an attractive "organic" product with no odor. Using a poor quality

filtercake (51% organic, 49% mineral, 0.6-0.8% N) we can now consistently produce a fertilizer containing 5-6% N. A higher analysis can be obtained using filtercake with less soil contamination. Amending ammoniated filtercake with a small amount of NH_4NO_3 should produce a fertilizer ideally suited for management of home lawns and commercial turfgrass. Inclusion of fly ash would increase K content but would also increase lead content, a heavy metal of environmental concern.

Table 1. Analysis of fly ash, filtercake, and filtercake ammoniated under optimum reaction conditions

	Fly Ash	FilterCake	Ammoniated Filtercake
	---------- N fractions (%) ----------		
Extractable inorganic N	0.08%	0.00%	0.03%
Water-sol org. N	0.00	0.01	1.47
Non-sol. org. N	0.00	0.73	4.86
	---------- Macro Nutrients (%) ----------		
P	0.5	1.1	1.2
K	3.3	1.6	1.6
S	0.1	0.5	0.5
	---------- Cations (%) ----------		
Na	0.7	0.6	
Ca	0.5	2.0	
Mg	0.2	0.5	
Al	0.2	3.0	
	---------- Trace elements (ppm) ----------		
Fe	9634	16551	
Mn	521	581	
Mo	32	33	
Zn	112	280	
	---------- Heavy metals (ppm) ----------		
Cd	14	17	
Co	27	25	
Cu	155	84	
Cr	68	70	
Hg	235	118	
Ni	45	51	
Pb	275	229	
As	97	94	

SUGARCANE RESPONSE TO SUBSURFACE DRAINAGE AFTER SEVERE 1989 FREEZE

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Introduction

In the sugarcane growing areas of southern Louisiana, the land is low lying and relatively flat, air temperatures are usually mild, and annual rainfall consistently exceeds evapotranspiration. Because of the low lying land and high rainfall, the water table often fluctuates near the soil surface.

High water tables often creates excessive soil-water conditions which adversely affect sugarcane roots and stubble. The adverse conditions caused by high water tables contribute to stubble diseases and root rotting which reduce yield and limit the number of stubble crops.

The high water table problem was recognized by pioneer sugarcane growers as indicated by the system that they developed for sugarcane production and which is still used today; i.e., closely spaced drainage ditches and high rows. The drainage ditches were installed to remove surface water and to lower the water table, while high rows were used to place the cane seed pieces and stubble as far above the water table as was practical. Although drainage ditches are sometimes effective in lowering the water table, they are not reliable means of water table control. After rainfall events, when drainage ditches are needed most, the ditches are very often filled with water and are ineffective in lowering the water table until the water level in the ditches recedes.

Subsurface drainage is recognized worldwide as an effective method for lowering the water table. The advantage of subsurface drainage, compared to surface drainage ditches, is that it is underground. Consequently, subsurface drains can be installed as close together as needed to lower the water table quickly after rainstorms without taking land out of production.

There are several cropping enhancements that have been attributed to a low water table. It enhances soil aeration, allows the soil to warm earlier in the spring, encourages root growth, reduces root disease and rotting, speeds soil drying at the surface so that soil tillage and cultivation can be done several days earlier after a large rainstorm, and reduces runoff, erosion, and pollution because more water soaks into the soil.

For many years, the soils in Louisiana and the adjacent states along the Mississippi River were considered too heavy (too much clay) to subsurface drain. This was based primarily upon laboratory tests where water movement through soil samples was very slow. However, tests in

The author wishes to acknowledge the landowner, M. A. Patout and Sons for their excellent cooperation in this study and the American Sugar Cane League for partial funding of the subsurface drain installation.

small field plots 0.01-acre in size at Baton Rouge during the late 1960s and early 1970s, demonstrated that silt loam soils drained readily. Not only did the soil drain in these plots, but sugarcane yield and stand longevity were increased because of the low water tables provided by subsurface drainage.

With positive soil and crop yield responses to subsurface drainage on small plots, the next step was to determine the responses in fields of several different soil types. Thus, the objective of this study was to determine soil and crop response to subsurface drainage on commercial-sized fields. Progress reports have been made on this long-term study since 1975. This paper gives the yield response of sugarcane to subsurface drainage during a unique sequence of climatological events -- a severe freeze in December, 1989, followed by excessive rainfall that caused high water tables during the first quarter of 1990.

Procedure

During the 1970s, subsurface drains were installed at several locations on different soil types, one of which was in Iberia Parish on Jeanerette silty clay loam soil in 1978. Four tracts of land each about 3.3 acres in size were selected for the project. Each tract was bordered by shallow field ditches and headlands. Four-inch diameter polyethylene, corrugated, plastic drains were installed four feet below the soil surface and spaced 45 feet apart in one tract (four drain lines in this tract), 90 feet apart in another tract (three drain lines in this tract) and 135 feet apart in the third tract (two drain lines in this tract). The drain outlets were connected to two sumps equipped with pumps for discharging drain effluent into a surface drainage ditch. The drains were spaced differently to determine the soil response to different drainage intensities. An area approximately 4 acres in size without subsurface drainage was used as a check. It was located across a drainage ditch from the 135 foot spacing tract.

The landowner used recommended practices in growing sugarcane. Three cropping cycles have been grown since drains were installed. The crop discussed in this paper was planted in the fall of 1988 with variety CP 70-321. Yields were determined by weighing the cane from four, 4-row heaps in each drained tract, and seven four-row heaps in the nondrained tract. The cane was sampled, and the sample analyzed for sugar content at the sugar mill's laboratory.

Rainfall was measured at the site with a chart recording raingauge. Air temperature was measured at the LSU Iberia Research Station at Jeanerette and reported by the National Weather Service. The water table was measured midway between two drains in each tract and at mid-plot in the nondrained tract. A six-inch diameter perforated pipe was installed vertically to a depth of five feet to measure the water table. A water stage recorder with a float and counter weight was used with this pipe to indicate the water table depths. The water table data charts were read and analyzed with a computer.

The summation of excess water within 45 cm of the soil surface (SEW_{45}) was determined for each tract to indicate how effective the drains were in maintaining the water table below the root zone. SEW (summation of excess water) is a concept developed by W. H. Sieben in the Netherlands for cereal grains. SEW is determined by summing the magnitudes and durations

of the water table within a selected distance (30 cm for most crops, 45 cm for sugarcane) of the soil surface. In actual practice, the water table elevation is plotted on a graph as water table elevation versus time, lines are drawn on the graph at the soil surface and at the selected distance below the soil surface, and the area under the plotted points describing the rise and fall of water table above the selected line (water table is within 45 cm of the soil surface) is calculated. The units for this calculation is cm-days (vertical distance times duration or time). For example, a water table that rises to 30 cm below the soil surface (15 cm above the 45 cm depth below the soil surface line) and remains there for two days would have a SEW_{45} value of 30 cm-days (15 cm x 2 days). The larger the SEW_{45} value, the more serious is the shallow water table problem. SEW_{45} rather than SEW_{30} is used for sugarcane because the practice of planting sugarcane on high rows, off barring the rows in the spring, and cultivating along the side of the rows until lay by, tends to encourage deep rooting. Thus, 45 cm seems to be a more reasonable depth to use in quantifying the water table position for sugarcane. Sebien observed that cereal grain yields declined as SEW_{30} increased from 100 to 200 cm-days during the growing season. Since SEW_{45} rather than SEW_{30} is used and since sugarcane culture differs from cereal grains in many ways but particularly in regards to stubble crops, a sugarcane yield decline is not expected until the SEW_{45} value is much greater than 200 cm-days.

Results and Discussion

The climatic conditions during the dormant and early growth period for the 1990 crop was unique because of the severe freeze in late December, 1989, followed by excessive rainfall during January through March, 1990. The maximum and minimum temperatures during the month of December are shown in Table 1. The maximum and minimum temperatures were observed and recorded at 8:00 a.m. daily. Thus, the temperatures shown in Table 1 are for the previous 24 hour period ending at 8:00 a. m. In most cases the maximum temperature shown in Table 1 actually occurred during the previous day while the minimum temperature probably occurred before or at 8:00 am on the day the readings were made. For example, the 50 degrees maximum temperature shown for December 26 probably occurred on December 25 while the 20 degree minimum temperature probably occurred before 8:00 a.m. on December 26.

As shown in Table 1, minimum temperatures were below freezing 12 of 31 days in December, 1989. The lowest temperature was 10 degrees F and it was observed on two days, the 23rd and 24th. The severe freeze extended over a seven-day period beginning December 21 with minimum temperatures of 31, 17, 10, 10, 12, 20, and 31 degrees Fahrenheit.

Damage to the sugarcane stubble by this cold weather cannot be determined directly because there was no unexposed cane stubble yields with which to compare. An estimate can be made of the damage by comparing the yield of the 1990 crop from a subsurface drained area with what one would expect from a first ratoon crop from a subsurface drained area. In the previous crop cycle of this subsurface drainage study, first ratoon from the drained area with 90-foot drain spacing yielded 5.2 percent more sugar than did the plant crop. If an assumption is made that a similar percentage increase would have occurred in 1990 without the severe cold temperatures, then the expected sugar yield would have been 7564 lbs/A (5.2 percent more than the plant crop yield of 7204 lbs/A). Actual yield, however, was only 3341 lbs/A. Thus, the 1990 yield was 55.8 percent less (4223 lbs/A less) than the estimated yield. Much of this

decrease is attributed to the severe cold temperatures in December, however, some decrease can be attributed to the lack of rainfall during the summer of 1990 since rainfall was below normal in April, May, July, and August (Table 2). None of the yield decrease is attributed to a high water table because the subsurface drains kept the water table well below the sugarcane roots and stubble for most of the year (Figure 1).

Sugar yield from the nondrained tract in 1990 was only 1321 lbs/A (Table 3). In the previous crop cycle (1984-1987) of this subsurface drainage study, sugar yield in the nondrained tract decreased from 5655 lbs/A in the plant crop to 5307 lbs/A in the first ratoon, a 6.15 percent decrease in yield. If an assumption is made that without adverse weather, a similar percentage decrease would have occurred from the plant crop in 1989 to the first ratoon in 1990, then the expected sugar yield would have been 5370 lbs/A (6.15 percent less than the plant crop yield of 5722 lbs/A). With an actual yield of 1321 lbs/A, yield from the nondrained area was 75 percent less than the estimated yield. This decrease is attributed to three adverse conditions affecting a crop -- the severe freeze in December 1989, a high water table during the dormant and early growth period, and below normal rainfall during the growing season. Most of the damage is attributed to the severe freeze in December and the high water table during the early months of 1990. The cane stand was devastated by these conditions. Plant population was only 7000 plants/A (Table 3). A desirable plant population is in the 30,000 to 45,000 plants/A range.

The SEW_{45} value for the nondrained tract in December 1989 was 285 cm-days. The water table was within 45 cm (18 inches) of the soil surface 19 days. SEW_{45} was 1739 cm-days from January to November 8, 1990, when the water table recorder was removed for cane harvest. The water table was within 45 cm of the soil surface 100 days during this period. The high water table that contributed to this SEW_{45} occurred mostly during January 2 through April 7, 1990 when SEW_{45} was 1512 cm-days. The water table was within 45 cm of the soil surface 81 days during this 95-day period. On the other hand, the water table in the subsurface drained tract was never within 45 cm of the soil surface during this 95-day period. In fact, the closest the water table came to the soil surface in the subsurface drained area (90-foot drain spacing) was on March 30 when it rose to 53 cm below the soil surface. This rise in the water table was due to a 3.15-inch rain that occurred within a 12-hour period beginning at 9:00 p.m. on March 29th. Usually the water table in the subsurface drained tract was two feet lower than the water table in the nondrained tract (See Figure 1). The average water table depth for the year was 59 cm (23 inches) below the soil surface in the nondrained area and 119 cm (47 inches) below the soil surface in the subsurface drained area.

The difference in sugar yield between the drained and nondrained tracts is attributed mainly to the difference in the water tables. Sugar yield from the subsurface drained area (90-ft drain spacing) was 2.72 times that in the nondrained tract (Table 2).

The treatments in this study were not replicated, thus, a true statistical analysis could not be made of the 1990 data. However, there were three subsurface drained tracts and two areas in the nondrained tract from which yields were measured. The average sugar yield from all three drain spacings was 3341 lbs/A which is 2.53 times that from the nondrained tract.

The stalk weights, as shown in Table 3, indicated very large stalks from both drained and nondrained areas. Actually, average stalk weight was less than 2 lbs/stalk. The stalk weights shown in Table 3 included cane stalks and some cane leaves that were left on the stalks. The cane in the nondrained area was particularly short and many leaves remained on the cane after it was cut and burned. The leaves left on the cane impacted the sugar yield as indicated by the relatively low sugar per ton of cane.

The water table data for the drained area shown in Figure 1 is from the block of land with subsurface drains spaced 90 feet apart. As indicated by the data in Table 3, yields from all three drain spacings were about the same but much higher than that in the nondrained area. Furthermore, SEW_{45} values for all drained area were very small, compared to that of the nondrained area in 1990, thus indicating that the subsurface drains were effective in keeping the water table out of the top 45 cm (18 inches) of the soil profile for most of the year. This information is welcome since it indicates that drains spaced 135 feet apart may be adequate for subsurface drainage of Jeanerette soil. The wider the drain spacing the lower the cost for installing subsurface drainage. For example, if drain installation costs were $0.50 per foot, the cost for drains spaced 90 feet apart would be $242/A, and for drains spaced 135 feet apart the cost would be $161/A. This does not include the cost of sump, pumps, and electricity.

The yield response of sugarcane to subsurface drainage reported in this paper reaffirm previously reported results that subsurface drainage increases sugar yields on Jeanerette silt loam soil. Thus, sugarcane growers should seriously consider installing subsurface drainage systems on soils such as Jeanerette silty clay loam.

TABLE 1. Maximum and minimum air temperatures during December 1989.

Day	Min	Max	Day	Min	Max	Day	Min	Max
	---(°F)---			---(°F)---			---(°F)---	
01	35	57	11	36	64	21	31	39
02	45	58	12	38	70	22	17	37
03	43	57	13	26	39	23	10	18
04	32	50	14	27	48	24	10	23
05	35	54	15	29	58	25	12	33
06	38	69	16	23	69	26	20	50
07	62	73	17	23	40	27	31	65
08	40	70	18	33	37	28	35	68
09	35	41	19	33	43	29	44	67
10	35	52	20	34	43	30	57	69
						31	61	69

TABLE 2. Monthly rainfall and departure from normal, 1990.

Month	Rainfall (inches)	Departure	Month	Rainfall (inches)	Departure
Jan.	2.67	- 1.75	Jul.	2.40	- 5.42
Feb.	7.57	+ 3.22	Aug.	3.81	- 2.66
Mar.	5.58	+ 1.70	Sep.	8.36	+ 3.24
Apr.	2.97	- 1.45	Oct.	2.63	- 0.90
May	3.33	- 1.65	Nov.	1.80	- 1.84
Jun.	6.95	+ 1.85	Dec.	6.35	+ 1.11

Table 3. Summary of 1990 Sugarcane Data from the Subsurface Drainage Experiment in Iberia Parish, Louisiana.

	Subsurface Drained			Nondrained
	45' spacing	90' spacing	135' spacing	
Sugarcane yield (tons/acre)*	24.20	25.23	27.68	13.85
Sugar yield (lbs/ton, CRS)	126.50	142.40	117.70	94.40
Sugar yield (lbs/acre, CRS)	3156	3599	3268	1321
Plant population (stalks/acre)	18444	19714	19956	7234
Stalk Weight (lbs/stalk)	2.73	2.78	2.80	3.89
Cane left in the field (T/A)	0.16	0.22	0.18	0.52

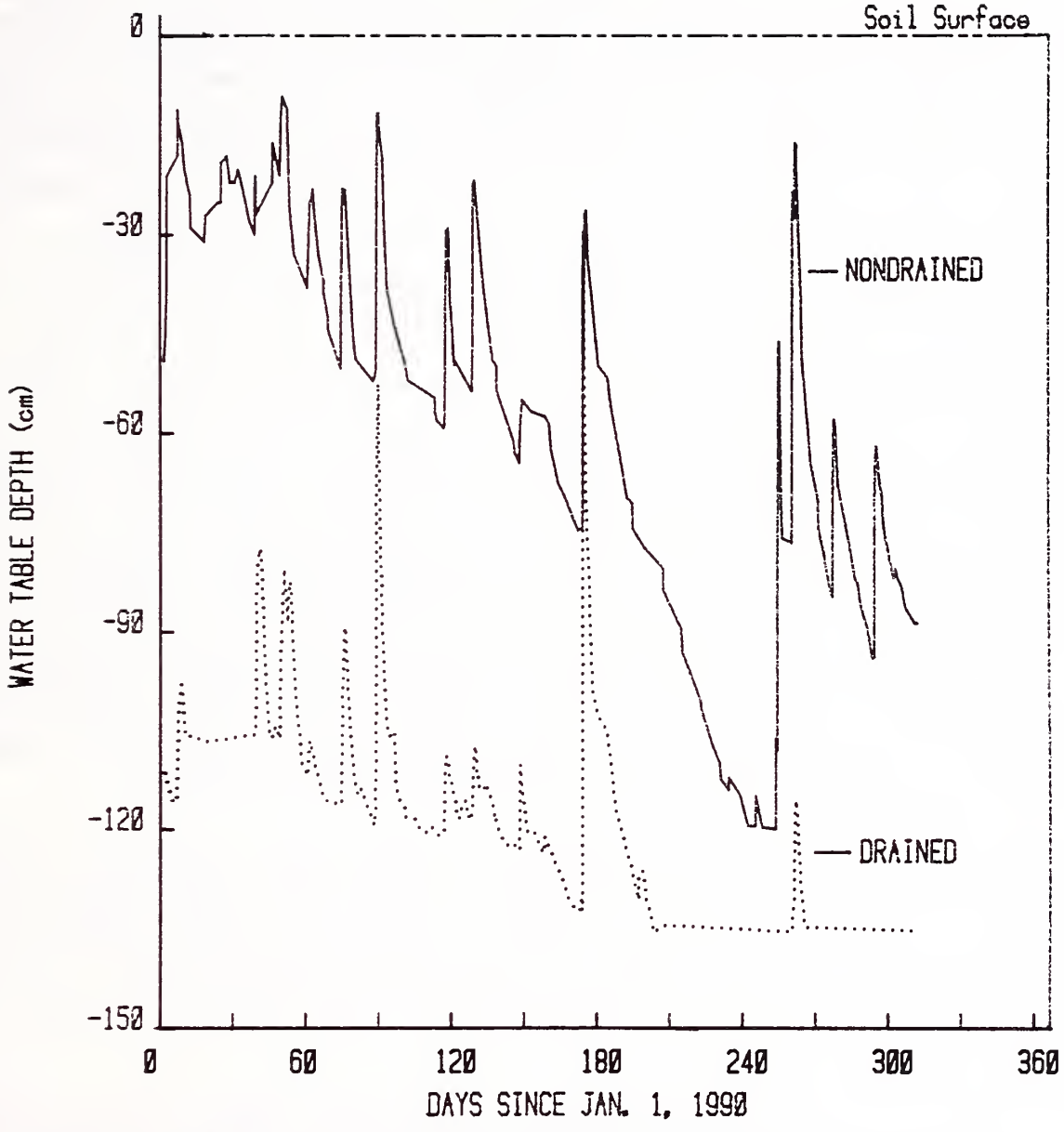

FIGURE 1. WATER TABLES IN SUBSURFACE DRAINED AND NONDRAINED AREAS DURING 1990.

ATRAZINE SOIL RESIDUES AND ALTERNATIVE HERBICIDES FOR SUGARCANE

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Atrazine residues were detected in canals and bayous in 6 south Louisiana parishes in 1989. The presence of atrazine, however, has not been detected in well water samples in Louisiana. Because of potential ground water contamination problems, atrazine has been designated as a restricted use pesticide. The total amount that can be legally used per year has been voluntarily reduced by the manufacturers, Ciba Geigy and DuPont. There has been some discussion by EPA concerning available alternative herbicides should atrazine be banned. The purpose of this project was to determine if atrazine residues occur in sugarcane soils in Louisiana and to evaluate potential alternatives for use in sugarcane.

In 1990, we collected 74 soil samples from sugarcane fields representing the cane belt area of Louisiana. Fields were selected where atrazine had been used for at least 2 years and where records of rates and times of application were available. Soil samples were collected from Assumption (39 samples), Iberia (6), Iberville (3), Lafourche (8), St. James (4), St. Martin (5), St. Mary (2), Terrebonne (3), and Vermilion (4) parishes. Analysis for atrazine was conducted at the LSU Feed and Fertilizer Laboratory under the supervision of Mr. Hershel Morris. Atrazine residues were below detection levels in 72 of the samples. In the remaining samples, levels were 0.08 ppm (Iberia parish) and 0.50 ppm (Terrebonne parish), equivalent to approximately 1 and 8 ounces of atrazine, respectively, in three inches of soil over an acre of land. The increased level in the Terrebonne sample, even though it is still very low, may have been due to the close proximity in time of sampling and layby application of atrazine in June. Overall, these finding suggest that the likelihood of long-term accumulation of atrazine in cane fields in Louisiana is low. Since atrazine persistence in soil would be necessary for its movement to ground water, the potential for ground water contamination should be minimal as well. These results pertain only to atrazine accumulation in soil and do not reflect the potential for surface runoff and subsequent contamination of above ground water sources such as canals and bayous.

We also evaluated several herbicides including Karmex (Direx), V-53482 (an experimental from Valent U.S.A. corporation), Facet (BASF Corporation), and Ally (DuPont) as potential alternatives to atrazine. The herbicides were applied as layby treatments on June 5 at the Hebert Farm in Thibodaux, LA using CP70-321 cultivar. Treatments were applied using one drop nozzle per row middle covering a 6 ft swath. Nozzle height was adjusted to allow the herbicide to contact the lower 15 inches of the sugarcane plant.

Cane injury on August 2 was minimal for all treatments except Ally where injury was 55% (Table 1). Even though red morningglory pressure was minimal, control was excellent for atrazine, Karmex, and Facet and good (84%) for Ally and V-53482. Sugarcane stalk populations and heights measured on August 30 were significantly reduced compared to the untreated check for only Ally. Both sugarcane and sugar yields following Facet were similar to the untreated check and higher than the other treatments. Plans are to repeat this study in 1991.

Table 1. The influence of herbicides applied at layby on red morningglory (RMG) control and sugarcane injury and yield at Thibodaux, LA 1990.

Treatment	Rate	Cane injury	RMG control	Stalk population	Stalk height	Cane yield	Cane Sucrose	Sugar yield
	lbs/A	(%)	(%)	(no./A)	(in)	(tons/A)	(%)	(lbs/A)
Atrazine	2.9	0	100	10,180	80	37.6	16.3	12305
Karmex	2.9	8	95	9,670	80	36.7	17.1	12540
Ally	0.06	55	84	3,430	50	31.7	14.3	9023
V-53482	0.06	5	84	10,070	79	39.2	17.4	13650
Facet	0.50	0	98	11,100	82	42.5	16.7	14173
Untreated ck	-	0	0	10,800	83	44.5	17.0	15084
LSD (0.05)		8	9	1,630	5	4.8	1.1	1456

RELATIONSHIP OF PLANT NUTRIENT ANALYSES[1] TO SUGARCANE SUGAR YIELDS ACROSS THREE YEARS

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Department of Agronomy

Summary

Multiple regression of sugar yield vs. tissue nitrogen, tissue potassium, and the nitrogen x potassium tissue interaction explained 85% of the variability in sugar yields across the three years (1987, 1988, and 1989) of plant, first stubble, and second stubble cane. Decreases in tissue nitrogen and potassium from plant cane to first and second stubble were associated with decreased sugar production. Further work is needed to determine if this is a cause and effect relationship.

Procedures

In the fall of 1986, a sugarcane nitrogen x phosphorus x potassium (2x2x3) soil fertility study was initiated at the Iberia Research Station on a Baldwin silty clay loam soil. Fertilizer treatments consisted of 80 and 160 lbs N/ac, 0 and 60 lbs P_2O_5/ac, and 0, 80, and 160 lbs K_2O/ac in all possible combinations. Each treatment was replicated three times. Plots were planted to variety CP 70-321 and fertilizer treatments were applied in April, 1987, 1988, and 1989. Plant leaf samples (leaf with the first visible dewlap) were taken on July 31, 1987, August 2, 1988, and August 3, 1989 and analyzed for nitrogen, phosphorus, potassium, calcium, magnesium, copper, manganese, zinc, iron, and sulfur concentrations. Sugar yields, relative sugar yields (% of highest yield for that year), nitrogen concentrations, relative nitrogen concentrations (% of highest nitrogen concentration for that year), phosphorus concentrations, relative phosphorus concentrations, potassium concentrations, and relative potassium concentrations were used in linear regression, curvilinear regression, and multiple regression analyses across the three years of the study.

Results

Fertilizer treatments, sugar yield, relative sugar yield, nitrogen, phosphorus, and potassium plant concentrations, relative nitrogen (RN), relative phosphorus (RP), and relative potassium (RK) tissue concentrations for plant cane, first stubble, and second stubble are given in Tables 1, 2, and 3, respectively. These data were used to calculate regressions across the three years of the study (Table 4). The regressions show that linear

[1]Partially funded by a grant from the American Sugar Cane League.

equations for yield vs. tissue nitrogen and yield vs. tissue potassium best explained the variability in yield across the three years. Also, relationships between yield and actual tissue concentrations were stronger than were relationships between relative yield and relative tissue concentrations, as is shown by their higher R^2 values (Table 4). Data also show that curvilinear regressions did not make a significant ($\underline{P}<0.10$) improvement over linear regressions in explaining variability of yield.

Multiple regressions and partial multiple regressions (Table 4) demonstrate that tissue N, tissue K and the tissue NxP interaction were all significantly ($\underline{P}<0.10$) related to yield. This indicates that the decrease in sugar yield from plant cane (Table 1) to first and second stubble cane (Tables 2 and 3, respectively) may have been caused by the decrease in plant nitrogen and potassium concentrations.

Table 1. Effect of fertilizer application on plant cane sugar yields and leaf nutrient concentrations on a Baldwin silty clay soil at the Iberia Research Station, 1987.

T#	Fertilizer Applied $N-P_2O_5-K_2O$	Sugar† Yield	RSY†	Concentrations and relative concentrations§ N	P	K	RN	RP	RK
	- - - lbs/ac - - -		%	- - - - - - - - - - % - - - - - - - - - -					
1	80-0-0	9,130	85.7	1.40	0.246	1.33	99.3	94.6	83.6
2	80-0-80	9,340	87.7	1.31	0.260	1.59	92.9	100.0	100.0
3	80-0-160	8,870	83.3	1.30	<u>0.206</u>	1.23	92.2	79.2	77.4
4	80-60-0	9,360	87.9	1.30	0.255	1.34	92.2	98.1	84.3
5	80-60-80	9,990	93.8	1.33	0.228	1.33	94.3	87.7	83.6
6	80-60-160	9,760	91.6	<u>1.32</u>	0.210	1.47	93.6	80.8	92.5
7	160-0-0	9,430	88.5	1.41	0.206	1.22	100.0	79.2	76.7
8	160-0-80	8,980	84.3	1.28	<u>0.182</u>	1.45	90.8	70.0	91.2
9	160-0-160	9,150	85.9	1.29	<u>0.185</u>	1.55	91.5	71.2	97.5
10	160-60-0	9,830	92.3	1.36	0.209	1.28	96.5	80.4	80.5
11	160-60-80	9,870	92.7	1.39	0.202	<u>1.29</u>	98.6	77.7	81.1
12	160-60-160	10,650	100.0	1.39	0.187	1.43	98.6	71.9	89.9
X		9,530		1.34	0.215	1.38			
LSD(0.10)		710							

†Extractable soil K, Ca, Mg, and P were 227, 2996, 698, and 181 ppm, respectively, at the start of the study; soil organic matter was 1.52%; and soil pH was 6.0. Experimental variety was CP 70-321. Cane was fertilized in April and harvested in December, 1987.

†RSY denotes relative sugar yield. Underlined treatments had significant ($\underline{P}<0.10$) yield increases with application of the indicated nutrient.

§N, P, K, RN, RP, RK denote concentrations and relative concentrations for each nutrient for first visible dewlap leaves taken on July 31, 1987.

Table 2. Effect of fertilizer application on first stubble sugar yields and leaf nutrient concentrations on a Baldwin silty clay soil at the Iberia Research Station, 1988.

T#	Fertilizer Applied $N-P_2O_5-K_2O$	Sugar Yield	RSY†	Concentrations and relative concentrations†					
				N	P	K	RN	RP	RK
	- - - lbs/ac - - -		%	- - - - - - - - - - - - % - - - - - - - - - - - -					
1	80-0-0	6,610	89.0	1.27	0.226	0.97	96.2	97.4	83.6
2	80-0-80	6,920	93.1	1.27	0.232	1.16	96.2	100.0	100.0
3	80-0-160	7,430	100.0	1.21	0.210	1.08	91.7	90.5	93.1
4	80-60-0	6,550	88.2	1.24	0.232	0.99	93.9	100.0	85.3
5	80-60-80	7,370	99.2	1.23	0.220	0.99	93.2	94.8	85.3
6	80-60-160	7,120	95.8	1.17	0.226	1.07	88.6	97.4	92.2
7	160-0-0	6,400	86.1	1.32	0.225	0.94	100.0	97.0	81.0
8	160-0-80	7,350	98.9	1.32	0.218	1.05	100.0	94.0	90.5
9	160-0-160	6,490	87.3	1.17§	0.212	1.15§	88.6	91.4	99.1
10	160-60-0	6,500	87.5	1.22	0.208	0.91	92.4	89.7	78.4
11	160-60-80	6,640	89.4	1.26§	0.225§	0.99	95.5	97.0	85.3
12	160-60-160	7,260	97.7	1.23	0.209	1.05	93.2	90.1	90.5
X		6,890		1.24	0.220	1.03			
LSD(0.10)		470							

†RSY denotes relative sugar yield. Cane was fertilized in April and harvested in November, 1988.

†Plant leaves at the first visible dewlap were taken on August 2, 1988. Treatments with underlined nutrient concentrations had significant ($P<0.10$) yield increases with application of the indicated nutrient.

§Denotes that yield decreases resulted from application of the indicated nutrient.

Table 3. Effect of fertilizer application on second stubble sugar yields and leaf nutrient concentrations on a Baldwin silty clay soil at the Iberia Research Station, 1989.

T#	Fertilizer Applied $N-P_2O_5-K_2O$	Sugar Yield	RSY†	Concentrations and relative concentrations†					
				N	P	K	RN	RP	RK
	- - - lbs/ac - - -		%	- - - - - - - - - - % - - - - - - - - - -					
1	80-0-0	6,340	83.8	1.20	<u>0.211</u>	0.86	89.6	79.0	77.5
2	80-0-80	7,010	92.6	1.31	0.211	1.07	97.8	79.0	96.4
3	80-0-160	6,900	91.1	1.22	0.171	0.87	91.0	64.0	78.4
4	80-60-0	7,380	97.5	1.22	0.267	0.98	91.0	100.0	88.3
5	80-60-80	7,400	97.8	1.17	0.211	1.01	87.3	79.0	91.0
6	80-60-160	7,390	97.6	1.16	0.189	1.10	86.6	70.8	99.1
7	160-0-0	6,260	82.7	1.33	0.198	<u>0.81</u>	99.3	74.2	73.0
8	160-0-80	7,160	94.6	1.33	0.183	1.11	99.3	68.5	100.0
9	160-0-160	6,360	84.0	1.18	0.179	1.04§	88.1	67.0	93.7
10	160-60-0	6,810	90.0	1.34	0.223	0.77	100.0	83.5	69.4
11	160-60-80	7,570	100.0	1.31	0.232	0.86	97.8	86.9	77.5
12	160-60-160	7,110	93.9	1.21	0.170	1.02	90.3	63.7	91.9
X		6,970		1.25	0.204	0.96			
LSD(0.10)		760							

†RSY Denotes relative sugar yield. Cane was fertilized in April and harvested in November, 1989.

†Plant leaves at the first visible dewlap were taken on August 3, 1989. Treatments with underlined nutrient concentrations had significant ($\underline{P}<0.10$) yield responses with application of the indicated nutrient.

§Denotes that a yield decrease resulted from application of the indicated nutrient.

Table 4. Relationship of plant nutrient concentrations versus sugar yields† across three years.

Linear Regressions

$R^2 = 0.3914^{**}$
$Y = -7,070 + 11,643(N)$

$R^2 = 0.0028$
$Y = 7,160 + 2,993(P)$

$R^2 = 0.7068^{**}$
$Y = 1,944 + 5,221(K)$

$R^2 = 0.0001$
$RY = 90 + 0.0101(RN)$

$R^2 = 0.0124$
$RY = 87 + 0.0539(RP)$

$R^2 = 0.0755^{\circ}$
$RY = 76 + 0.1789(RK)$

Curvilinear Regressions

$R^2 = 0.4271^{**}$
$Y = 73,333 - 114,468(N) + 49,300(N)^2$

$R^2 = 0.0155$
$Y = 16,543 - 85,098(P) + 204,351(P)^2$

$R^2 = 0.7070^{**}$
$Y = 2,496 + 4,248(K) + 413.7(K)^2$

$R^2 = 0.0029$
$RY = 260 - 3.597(RN) + 0.0192(RN)^2$

$R^2 = 0.0131$
$RY = 67 + 0.5387(RP) - 0.0030(RP)^2$

$R^2 = 0.1271^{\circ}$
$RY = -53 + 3.1794(RK) - 0.0173(RK)^2$

Multiple Regressions

$R^2 = 0.8098^{**}$
$Y = -5,395 + 6,495(N) + 4,369(K)$

$R^2 = 0.8464^{**}$
$Y = 33,345 - 23,319(N) - 30,680(K) + 26,872(N)(K)$

Partial Regressions

N^2	after	N:	0.0357°
P^2	after	P:	0.0127
K^2	after	K:	0.0002
RN^2	after	RN:	0.0020
RP^2	after	RP:	0.0007
RK^2	after	RK:	0.0516

Partial Multiple Regressions

K after N: 0.4184^{**}
N after K: 0.1038^{**}
(N)(K) after N + K: 0.0366^{**}

†Y, N, P, K, RN, RP, RK denote lbs sugar/ac, % tissue N, % tissue P, % tissue K, % relative N, % relative P, and % relative K, respectively.
°, **Denote statistical significance at the $P<0.25$ and 0.01 levels, respectively.

SUGARCANE RESPONSE TO NITROGEN, PHOSPHORUS, POTASSIUM, AND SULFUR

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Summary

In the spring of 1990 fifteen soil fertility treatments were imposed on plant cane on a Loreauville silty loam soil at the Bayside Plantation near Jeanerette. Cane yields responded significantly ($P<0.10$) to fertilization with nitrogen, phosphorus, and potassium; and sugar yields responded to nitrogen and potassium. Neither cane nor sugar responded significantly to super urea or gypsum.

Materials and Methods

A sugarcane outfield soil fertility study was established at the Bayside Plantation near Jeanerette on a Loreauville silty loam soil using second progeny heat treated CP 70-321. The fifteen fertilizer treatments listed in Table 1 were applied in the offbar on April 23, 1990. The rows were hipped up and standard practices were followed until the cane was harvested on November 11.

All treatments were replicated three times in a randomized complete block design. Plots consisted of three 5.83 x 40' rows with four foot alleys between the plots. Yields were calculated from whole plots.

Plant leaf tissue (at the first visible dewlap) was taken from the center row of each plot at the end of July, August, and September. This tissue is now being analyzed for mineral elements for use in interpreting the response to fertilizer application.

Results and Discussion

Nitrogen fertilization increased ($P<0.10$) cane yields for T#'s 1, 4, and 7, but had no significant effect on T#'s 2, 3, 5, 8, 9, and 10 (Table 1).

Cane yields were not affected by phosphorus fertilization. However, potassium addition increased yields for T# 7, but not for the other treatments. Addition of super urea (T# 6 vs. T# 5) and sulfur as gypsum (T# 15 vs. T# 14) did not affect cane yields. Thirteen of the 14 treatments receiving fertilizer (T#'s 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, and 15) had higher cane yields than the check (T# 1).

Sugar yields increased with nitrogen application to T#'s 2 and 7, while T#'s 3, 4, 5, 8, 9, and 10 were not significantly affected (Table 1). Phosphorus fertilization had no significant effect on

sugar yields, and potassium increased yields of T#'s 7 and 8, but not T#'s 2, 3, 11, and 12. Super urea (T# 6 vs. T# 5) and gypsum (T# 15 vs. T# 14) had no effect on sugar yields. Ten of the fourteen treatments receiving fertilizer (T#'s 3, 5, 6, 9, 10, 11, 12, 13, 14, and 15) had higher sugar yields than the check.

Table 1. List of experimental treatments and yield parameters.

Treatments†	Fertilizer applied				Cane yield	Sugar yield
	N	P_2O_5	K_2O	S		
	- - - - lbs/ac - - - -				tons/ac	lbs/ac
1	0	0	0	0	31.6 e	6370 e
2	60	0	0	0	34.1 cd	6530 de
3	60	40	0	0	35.8 abc	7100 abcd
4	60	0	80	0	34.7 bcd	6930 bcde
5	60	40	80	0	36.6 ab	7180 abc
6	60	40	80	0SU	36.8 ab	7450 ab
7	120	0	0	0	33.3 de	6450 e
8	120	40	0	0	35.2 abcd	6760 cde
9	120	0	80	0	36.7 ab	7410 ab
10	120	40	80	0	37.5 a	7570 a
11	180	0	0	0	36.3 abc	7190 abc
12	180	40	0	0	36.2 abc	7240 abc
13	180	0	80	0	37.3 a	7480 ab
14	180	40	80	0	36.0 abc	7230 abc
15	180	40	80	24	37.0 ab	7230 abc
LSD (0.10)					2.3	610
% CV					4.66	6.21

†Fertilizer sources for N, P, and K in treatments 2 through 5 and 7 through 14 were ammonium nitrate, triple super phosphate, and potassium chloride, respectively. Treatment 15 received 24 lbs/ac of S as ammonium sulfate and the remaining N as ammonium nitrate. Treatment 6 received all of its N as Agrico Super Urea, and its P and K as triple super phosphate and potassium chloride, respectively.

NITROGEN FERTILIZER STUDY

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Summary

Seven nitrogen rates (0, 40, 80, 120, 160, 200, and 240 lbs N/ac) were applied in the spring to CP 70-321 plant cane on a Baldwin silty clay loam soil at the Sterling Plantation. Significant ($P<0.10$) yield responses of cane and sugar to nitrogen application were not obtained in 1990. The study will be repeated on the same plots in 1991 using first stubble cane.

Material and Methods

Seven nitrogen rates (0, 40, 80, 120, 160, 200, and 240 lbs N/ac as ammonium nitrate) were applied on May 2, 1990 to CP 70-321 plant cane on a Baldwin silty clay loam soil at the Sterling Plantation in Franklin. Fertilizer treatments were randomly applied in a complete block design experiment with all treatments replicated three times. Plots consisted of three 5.33 x 50' rows with four foot alleys separating the plots. Cane and sugar yields were calculated from whole plots.

Coded nitrogen fertilizer rates (Table 1) were regressed against the measured yield parameters across all 21 plots to obtain the orthogonal regressions in Table 2.

Results

Results show that the range of nitrogen rates used in this study (Table 1) did not have a significant effect ($P<0.10$) on either cane or sugar yield (Table 2). However, various nitrogen terms in the orthogonal regressions were significant for brix, sucrose, pol, and stalk number.

Since the results are for plant cane, it is not surprising that cane and sugar yields did not respond to nitrogen fertilization. The study will be continued on the same plots in 1991, where yield response to nitrogen is anticipated.

Table 1. Nitrogen fertilizer treatments for sugarcane soil fertility study conducted at Sterling Plantation in St. Mary Parish in 1990.

CODED VALUES	Nitrogen applied[1] lbs N/ac
-3	0
-2	40
-1	80
0	120
1	160
2	200
3	240

[1]Nitrogen was applied in the offbar as ammonium nitrate on May 2, 1990.

Table 2. Curvilinear regressions of coded nitrogen rates against yield parameters.

	Cane[1] yield	Brix	Sucrose	Purity	Pol	Sugar	Stalk number	Stalk weight
I	28.4508	17.5000**	14.6381**	83.6429**	77.0206**	5967.5556**	24.3111**	2.4937**
N	0.5515	-0.2430*	-0.2337*	-0.1774	-1.3979*	13.0503	-0.0615	-0.0141
N^2	0.0492	-0.0012	0.0179	0.1071	0.0817	33.2539	-0.2111§	-0.0060
N^3	-0.0380	0.0315*	0.0278§	0.0083	0.1630§	-0.4630	0.0472	0.0006
R^2	0.0518	0.2530	0.2337	0.1945	0.2426	0.0320	0.2320	0.0303
%CV	10.50	1.97	2.52	1.19	2.74	11.70	8.14	7.49

[1]Plant cane used in the study was CP 70-321.
**, *, and § denote statistical significance at the $P<0.01$, 0.05, and 0.10 levels, respectively.

SOIL FERTILITY RESEARCH WITH SUGARCANE IN 1990

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in cooperation with
St. Gabriel and Iberia Research Stations and Cane Growers

Summary

Five field experiments were conducted in soil fertility with sugarcane in 1990. Two other experiments were discontinued due to freeze damage to over-wintering cane stubbles. The experiments conducted were on rates of fertilizer, fertilizers and a soil pesticide in succession cane and rates of gypsum. In an NPK test on a Commerce soil, plant cane yields were increased with 60 lbs./A of N, 60 lbs./A of phosphate and 80 lbs./A of potash. Higher rates did not increase yield. In another test on a Loreauville soil plant cane yields were increased with 180 lbs./A of N and 80 lbs./A of potash. Lower N rates and phosphate did not increase yield. An N rate test on a Commerce soil showed that sugar yields were increased with 120 lbs./A of N, but not above that rate.

A succession cane test on a Commerce soil showed that the sugar yields in stubble cane were increased with fall applied fertilizers and Furadan. A gypsum test on an Alligator clay soil indicated that 10-ton/A rate continued to increase cane yield in first stubble during a second cane cycle after the gypsum application.

Objectives

The research was designed to provide information in an effort to help cane growers to produce maximum economic yields and to increase profitability in sugarcane production. This annual progress report is presented to provide the latest available data on certain practices and not as a final recommendation for growers to use all of these practices. Recommendations are based on several years of research data.

Results and Discussion

Five field experiments were conducted in soil fertility in sugarcane in 1990. Freezing temperatures with a minimum of 8°F occurred in December, 1989 and caused severe damage to over-wintering cane stubbles in some of the experiments. Also, heavy rainfall during the winter months reduced cane stands in the 1990 crop. Two of the experiments in progress in stubble cane were relocated in plant cane fields and an additional two experiments were discontinued due to freeze damage.

Rates of Fertilizer Application. An experiment was initiated to test rates of fertilizer application on yield of plant cane on a Commerce silt loam soil on the St. Gabriel Research Station. The

fertilizer treatments consisted of 60, 120, 180 and 240 lbs./A of N, 0 and 60 lbs./A of phosphate and 0, 80 and 160 lbs./A of potash. Variety CP65-357 was planted on the plots and the treatments were applied in April, 1990. The plant cane yield data obtained in November are reported in Table 1. Each fertilizer treatment increased the cane and sugar yields over the check plot without applied fertilizer. The yield increase from 60 lbs./A of N was significant, but increases from higher N rates alone were small. The phosphate increased yield only with 180 lbs./A of N and 80 lbs./A of potash. Potash at the 80 lbs./A rate increased yields with 60 and 180 lbs./A of N and the phosphate treatments. The yield differences from 160 over 80 lbs./A of potash were small.

An experiment was conducted to test rates of fertilizer application on yield of plant cane on a Loreauville silt loam soil on Bayside Plantation in Iberia Parish. The fertilizer treatments consisted of 60, 120 and 180 lbs./A of N, 0 and 40 lbs./A of phosphate and 0 and 80 lbs./A of potash in all possible combinations. Also, 60-40-80 using urea as the N source and 180-40-80 plus 24 lbs./A of sulfur were included as treatments in the test. Variety CP70-321 was planted in the plots and the treatments were applied in April, 1990. The plant cane data obtained in November are reported in Table 2. The cane and sugar yield increases from 60 and 120 lbs./A of N alone were small but the increase from 180 lbs./A of N was significant. The yield increases from phosphate were small. The potash alone and potash plus phosphate treatments increased yield at the 120 lbs./A rate of N. The increases from the urea source of N and sulfur were small.

An experiment was initiated with plant cane to test rates of nitrogen applications on cane and sugar yield. The test was on a Commerce silt loam soil on Jerry Woods Welcome Farms in St. James Parish. The N rates were 0, 60, 120, 180 and 240 lbs./A. Variety CP72-370 was planted in the plots and the fertilizer treatments were applied in April, 1990. The plant cane yield data obtained in November are reported in Table 3. There was a trend for each N rate to increase the cane yield, but only the 240 lbs./A rate significantly increased tons of cane per acre. However, the 120, 180 and 240 lbs./A rates significantly increased the sugar per acre yields. The yield increases were due principally to increases in stalk population and percent sucrose in the cane.

Fertilization of Succession Cane. An experiment was continued with second stubble in 1990 from succession planted sugarcane to determine the effects of applying fertilizers and Furadan nematicide in the fall and spring on cane yield. This test was planted in 1987 in succession following a three-year cycle of cane which was also planted in succession with a previous cane crop in 1984. The fertilizer and Furadan treatments applied in this test were the same as those applied in the first cycle of succession cane. The treatments consisted of a fall application of 0-0-0 and 90-90-90 fertilizer at planting time and a spring application of 120-0-80 and 240-0-160 fertilizers in each crop year. Furadan at a rate of 10 lbs./A was applied at planting time and in the spring

of each crop year. The test was conducted on Commerce silt loam soil on the St. Gabriel Research Station.

The yield data obtained with second stubble cane in 1990 are reported in Table 4. This succession cane was the only test in second stubble cane that survived the severe freeze. However, there was some minor freeze damage to cane causing a relatively high experimental error. The differences in sugar yields were significant, but not in cane yields. There was a trend for more increase in cane yield from fall fertilizer without Furadan and from Furadan without fall fertilizer. Sugar yields were increased with fall fertilizer plus Furadan over a check plot. As an average of the fertilizer treatments, Furadan significantly increased the sugar yield per acre.

Gypsum Test. A test was continued with first stubble in a second cycle of cane after the application of gypsum rates on an Alligator clay soil on Jackie Judice Farm in Iberia Parish. The treatments consisting of 0, 1, 2.5, 5 and 10 Tons/A of mined gypsum were applied prior to planting in 1984. A cycle of cane crop was grown in 1985-87 and a second cycle was planted in 1988 without reapplying the gypsum treatments. This was done to determine the long-term effects of relatively high gypsum rates on cane yield.

The yield data obtained in first stubble cane in 1990 are reported in Table 5. The increases in cane yield from the 1-2.5- and 5-ton rates were similar and small. The increase in cane yield from the 10-ton rate was significant. This was due principally to an increase in stalk population. However, the increases in percent sucrose and sugar per acre were not significant.

Table 1. Effect of rate of fertilizer application on the yield and yield components of plant cane on a Commerce silt loam soil on St. Gabriel Research Station, 1990.

Fertilizer applied $N-P_2O_5-K_2O$	Plant cane yield	Stalk		Normal juice		Sugar yield
		No.	Wt.	Brix	Sucrose	
lbs/A	T/A	1000/A	lbs.	%	%	lbs/A
0-0-0	19.2	19.6	2.26	16.1	13.2	3548
60-0-0	30.2	26.8	2.38	16.3	13.2	5597
60-60-0	28.9	26.1	2.38	16.8	13.6	5566
60-0-80	30.9	24.9	2.46	16.6	13.5	5887
60-60-80	34.5	27.1	2.64	15.5	12.3	5936
120-0-0	28.2	24.0	2.41	17.2	14.0	5625
180-0-0	30.1	26.1	2.38	18.0	14.8	6433
180-60-0	30.1	25.8	2.49	17.5	14.1	6031
180-0-80	29.6	25.4	2.54	17.3	14.2	6033
180-60-80	36.5	29.9	2.45	17.1	14.0	7301
240-0-0	30.0	26.0	2.63	16.4	13.4	5680
240-0-160	30.9	26.2	2.60	17.5	14.4	6398
LSD .05	4.2	3.5	0.32	2.0	2.1	1604

The experiment was conducted with plant cane of Variety CP 65-357 and the cane was fertilized in April and harvested in November, 1990.

Table 2. Effect of rate of fertilizer application on the yield and yield components of plant cane on a Jeanerette silt loam soil on Bayside Farms in Iberia Parish, 1990.

Fertilizer applied $N-P_2O_5-K_2O$	Stubble cane yield	Stalk		Normal juice		Sugar yield
		No.	Wt.	Brix	Sucrose	
lbs/A	T/A	1000/A	lbs.	%	%	lbs/A
0-0-0	31.6	23.4	2.96	17.1	14.1	6370
60-0-0	34.1	24.1	3.26	16.7	13.6	6525
60-40-0	35.8	26.4	3.04	17.0	13.9	7099
60-0-80	34.7	25.7	3.24	16.9	14.0	6928
60-40-80	36.6	25.9	3.04	16.9	13.8	7182
60-40-80 SU	36.8	26.1	2.99	17.0	14.1	7448
120-0-0	33.3	24.1	3.14	16.8	13.7	6455
120-40-0	35.2	26.7	3.13	16.7	13.5	6757
120-0-80	36.7	26.2	3.20	17.3	14.1	7409
120-40-80	37.5	25.6	3.23	17.2	14.1	7570
180-0-0	36.3	28.1	3.19	17.0	13.9	7188
180-40-00	36.2	26.1	3.01	17.0	14.1	7243
180-0-80	37.3	25.6	3.16	17.2	14.1	7484
180-40-80	36.0	26.8	3.15	17.3	14.1	7229
180-40-80 +24S	37.0	26.2	3.01	17.3	13.7	7229
LSD .05	2.8	2.2	NS	0.6	0.6	735

SU = Urea source of nitrogen
S = Sulfur

The experiment was conducted with Variety CP70-321 and the cane was fertilized in April and harvested in Movember, 1990.

The test was in coopertation with Dr. W. B. Hallmark, Iberia Research Station.

Table 3. Effect of rate of nitrogen fertilizer application on the yield and yield components of plant cane on a Commerce silt loam on Jerry Woods Farms in St. James Parish, 1990.

Fertilizer applied $N-P_2O_5-K_2O$	Plant cane yield	Stalk		Normal juice		Sugar yield
		No.	Wt.	Brix	Sucrose	
lbs/A	T/A	1000/A	lbs.	%	%	lbs/A
0-0-0	27.8	24.4	2.47	16.7	13.5	5378
60-0-0	29.7	24.9	2.50	16.9	13.8	5847
120-0-0	31.0	27.3	2.51	18.0	14.8	6596
180-0-0	31.3	26.0	2.63	18.0	14.7	6607
240-0-0	32.9	27.8	2.43	17.5	14.3	6733
LSD .05	3.9	2.4	NS	NS	NS	1177

The experiment was conducted with variety CP 72-370 and the cane was fertilized in April and harvested in November, 1990.

Table 4. Effect of fall and spring applications of fertilizers and Furadan nematicide on the yield and yield components of second stubble cane from planting in succession without a fallow year on Commerce silt loam soil at the St. Gabriel Research Station, 1990.

Fertilizer $N-P_2O_5-K_2O$		Stubble cane	Stalk		Normal juice		Sugar
Fall	Spring	yield	No.	Wt.	Brix	Sucrose	yield
lbs/A	lbs/A	T/A	1000/A	lbs.	%	%	lbs/A
			Succession - No Furadan				
0-0-0	120-0-80	19.9	22.3	1.91	17.1	13.8	3892
	240-0-160	18.9	20.9	2.01	16.3	12.7	3355
90-90-90	120-0-80	22.0	25.9	2.00	15.9	12.3	3727
	240-0-160	21.4	24.0	2.07	16.6	13.2	3954
No Furadan Mean		20.5	23.3	2.00	16.5	13.0	3732
			Succession - 10 lb/A Furadan				
0-0-0	120-0-80	22.4	26.3	2.03	16.8	13.4	4225
	240-0-160	23.5	27.9	2.11	16.3	12.7	4173
90-90-90	120-0-80	21.6	23.0	2.00	17.0	13.6	4136
	240-0-160	23.0	27.2	2.20	17.0	13.5	4384
Furadan Mean		22.6	26.1	2.09	16.8	13.3	4229
LSD .05 Treatment		NS	5.9	0.20	NS	1.4	968
LSD .05 Furadan Means		NS	NS	NS	NS	NS	484

This test was planted in 1987 in succession following a three-year cycle of cane which was also planted in succession with a previous cane crop in 1984. Cane variety CP 70-321 was planted in the test and the fall fertilizer and Furadan treatments were appled at planting time. The spring fertilizer and Furadan treatments were applied in April and the second stubble cane was harvested in November, 1990.

The extractable soil K, Ca, Mg and P were 117, 2036, 360 and 106 ppm, respectively, with a soil organic matter of 0.99% and pH 6.2.

Table 5. Effect of rates of mined gypsum on the yield of first stubble cane in a second cycle of cane after application on an Alligator clay soil on Jackie Judice Farm in Iberia Parish, 1990.

Mined gypsum applied[1/]	Plant cane yield	Millable stalk Wt.	Normal Juice		Sugar yield
			Brix	Sucrose	
T/A	T/A	lbs.	%	%	lbs/A
0	23.0	1.75	18.8	14.9	4909
1	24.5	1.74	18.2	14.1	4898
2.5	24.1	1.77	18.6	14.5	4994
5	24.9	1.81	18.4	14.3	5094
10	25.8	2.01	18.8	14.7	5460
LSD .05	2.4	0.22	NS	NS	NS

The gypsum treatments were applied broadcasted and disked into the soil prior to planting cane in 1984. A cycle of cane crops was grown in 1985-87 and Variety CP 65-357 was planted in 1988 for a second cycle. The treatments were applied prior to the first cycle, but not prior to the second cycle.

This test was conducted in cooperation with Dr. Howard Viator, Iberia Research Station.

CULTURAL PRACTICE RESEARCH WITH SUGARCANE IN 1990

Ray Ricaud and Allen Arceneaux
Agronomy Department

in cooperation with
St. Gabriel and Iberia Research Stations

Summary

Six field experiments were conducted on cultural practices in sugarcane in 1990. Five other experiments were discontinued due to freeze damage to cane stubbles with a minimum temperature of 8°F during December of 1989. The experiments conducted were on dates of planting and harvesting, stubble protection and longevity and stubble diggers.

Results showed that average yields of four varieties were higher in plant cane by planting on October 1 and in stubble cane by planting on September 1 or October 1. A late harvest date (December 1) increased the sugar yields, but not the cane yield of plant cane. A soil cover on cane stubbles after harvesting a plant cane crop reduced freeze damage and increased the yield of the following stubble crop. The freeze damage and yield responses to soil cover were much greater after harvesting in November and December than in October. In a longevity test, cane yields were increased with the use of Kleen-Tek seed and a soil cover, but not with soil pesticides. The use of a stubble digger and a Lilliston cultivator increased yields in stubble cane. The increases were larger with the digger than the cultivator.

Objectives

The research was designed to provide information in an effort to help cane growers to produce maximum economic yields and to increase profitability in sugarcane production. This annual progress report is presented to provide the latest available data on certain practices and not as a final recommendation for growers to use all of these practices. Recommendations are based on several years of research data.

Results and Discussion

Six field experiments were conducted on cultural practices in sugarcane in 1990. Freezing temperatures with a minimum of 8°F occurred in December, 1989 and caused severe damage to cane stubbles in some of the experiments. Also, heavy rainfall during the winter months reduced cane stands in the 1990 crop. Five other experiments in progress on cultural practices were discontinued due to freeze damage.

This research was supported in part by grant funds from the American Sugarcane League.

Date of Planting. An experiment was initiated to determine the effects of planting dates on the plant cane yield of four current varieties of sugarcane. The dates tested were September 5, October 1 and November 2 and the varieties were CP70-321, CP72-370, CP74-383 and CP79-318. The varieties were planted on each date in 1989 and harvested as plant cane in late November, 1990. The cane planted in November was damaged by a severe freeze and only the data obtained for the September and October dates are reported in Table 1. The results show that higher yields were produced from the October than the September planting in varieties CP74-383 and CP79-318 and in the average of all varieties. The yield increases were due mainly to the increases in stalk population.

Another test was continued in 1990 from plant cane in 1989 to determine the effects of planting dates on the first stubble yield of four cane varieties. The dates were September 1, October 3 and November 2 and the varieties were CP70-321, CP72-370, CP74-383 and CP76-331. The varieties were planted on each date in 1988 and harvested as plant cane in 1989 and first stubble in 1990. The yield data obtained in first stubble are reported in Table 2. Variety CP70-321 produced more stubble cane yield when planted in September and October than in November. The effects of planting dates on the stubble yield of the other varieties were not significant. However, as an average of varieties, the September and October plantings increased yields over the later planting date.

Date of Harvest. Experiments were conducted on dates of harvesting four current varieties of sugarcane. One test was initiated to determine the effects of harvest dates in plant cane in 1990 and stubble cane in 1991. Varieties CP70-321, CP72-370, CP79-318 and LCP82-89 were harvested on September 1, October 1, November 1 and December 1 in 1990. The plant cane data for the last three dates are reported in Table 3. The effects of the harvest dates on cane yield and stalk population of each variety were not significant. Generally, the average stalk weight and percent sucrose increased during the harvest season. As an average of varieties, the sugar yields per acre were higher when the plant cane was harvested in December than in October. As an average of harvest dates, the new variety LCP82-89 produced 40.5% more cane yield and 30.4% more sugar yield per acre than CP70-321.

Another test was initiated in 1989 to determine the effects of harvest dates on the yield of plant cane in 1989 and the following first stubble crop in 1990. The stubble cane was damaged by a freeze and the yields were not measured in 1990.

Stubble Protection. An experiment was conducted on stubble protection from freeze damage to possibly increase the yield and longevity of stubble cane. The protection treatments consisted of covering the cane stubble with approximately three inches of soil after harvesting a crop and a check plot without covering. The soil cover was applied prior to the occurrence of a freeze and the cover was removed in the following spring with a stubble shaver.

The test consisted of two soil cover application dates and three harvest dates in varieties CP70-321 and CP72-370. Plant cane of each variety was harvested on October 1, November 1 and December 1 in 1989. The soil cover was applied immediately after each harvest date and at the end of the harvest season on separate plots. The first stubble cane was harvested in November, 1990 and the data are reported in Table 4.

The first stubble cane yield was significantly increased by the soil cover treatment for each harvest date of each variety. The freeze damage on the uncovered check plots and the yield increases due to the soil cover were more in variety CP70-321 than CP72-370. Also, the freeze damage and yield increases were more where plant cane was harvested in November and December than in October. The yield increases were larger where the cane stubbles were covered immediately after each harvest date than at the end of the harvest season. As an average of varieties and harvest dates, the soil cover applied immediately after harvesting increased cane yield 18.4 T/A or 178.6% and the cover applied at the end of the season increased yield 15.5 T/A or 150.5% over the check plots. Apparently, the regrowth from cane harvested early gave some canopy protection from freeze damage on the uncovered check plots.

Stubble Longevity. An experiment was continued in cooperation with Dr. Howard Viator at the Iberia Research Station to test the effects of seed sources, soil pesticides and stubble protection in first stubble cane. The test was planted in 1988 with Kleen-Tek and "field run" seedcane of variety CP72-370 on an Iberia clay soil. The percent ratoon stunt disease was 15.0% in the "field run" seed and zero in the Kleen-Tek seed. Furadan was applied at planting time and Ridomil and Furadan were applied in the spring in the plant cane and first stubble crops. A soil cover treatment was applied after harvesting plant cane in 1989 and its effect was measured in first stubble in 1990.

The mean effects of each treatment obtained in the first stubble are reported in Table 5. The Kleen-Tek seedcane produced 6.4 T/A or 21.5% more cane yield than the "field run" seed. The Furadan and Ridomil treatments did not increase yield. The soil cover increased the first stubble yield 3.1 T/A or 9.8% over the uncovered check plot. The freeze damage and yield response to soil cover were less in this test than on the St. Gabriel Station probably due to differences in soil types and minimum winter temperatures.

Stubble Digger and Lilliston Cultivator. Experiments were conducted in 1990 to evaluate the use of a stubble digger and a Lilliston cultivator on germination and yield of stubble cane. The digger and cultivator were tested in first stubble of CP72-330 and in second stubble of CP65-357. The treatments were applied after false shaving the old cane stubbles in early March. The data reported in Table 6 show that the yield increases with the use of the digger and Lilliston were significant in the first stubble, but not in the second stubble test. This was probably due to more

freeze damage causing poor cane stands and a larger experimental error in the older stubble. However, as an average of the two tests, the digger and Lilliston significantly increased cane yield over the check plot. Results in previous years indicated that the use of the same digger and Lilliston damaged germinating buds and caused a reduction in cane yields.

Table 1. Effect of date of planting on the plant cane yield of four varieties of sugarcane on Commerce soil at the St. Gabriel Research Station, 1990.

Variety of cane	Date of planting	Plant cane yield	Stalk		Normal juice		Sugar yield
			No.	Wt.	Brix	Sucrose	
	1989	T/A	1000/A	lbs.	%	%	lbs/A
CP 70-321	Sept. 5	29.2	24.5	2.66	18.2	15.3	6459
	Oct. 1	30.6	26.9	2.50	17.7	14.8	6536
CP 72-370	Sept. 5	32.2	27.5	2.47	17.8	14.3	6562
	Oct. 1	34.6	28.8	2.59	18.1	14.9	7447
CP 74-383	Sept. 5	30.7	25.3	2.83	17.5	14.5	6679
	Oct. 1	34.8	27.3	2.55	17.7	14.6	7263
CP 79-318	Sept. 5	30.0	17.2	3.98	17.8	15.0	6486
	Oct. 1	34.1	21.7	3.45	17.6	14.6	7191
LSD .05 Treatments		2.8	2.6	0.28	0.3	0.6	694
		Mean Planting Date Effect					
	Sept. 5	30.5	23.6	2.99	17.8	14.8	6547
	Oct. 1	33.6	26.2	2.77	17.8	14.7	7110
LSD .05 Means		1.4	1.3	NS	NS	NS	347

Data from November planting date lost due to freeze.

Table 2. Effect of date of planting on the first stubble cane yield of four varieties of sugarcane on Commerce soil at the St. Gabriel Research Station, 1990.

Variety of cane	Date of planting	Stubble cane yield	Stalk		Normal juice		Sugar yield
			No.	Wt.	Brix	Sucrose	
	1988	T/A	1000/A	lbs.	%	%	lbs/A
CP 70-321	Sept. 1	23.3	27.2	2.23	17.7	14.7	4925
	Oct. 3	24.2	25.5	2.32	17.6	14.6	5075
	Nov. 2	16.6	14.8	2.23	18.0	14.6	3471
CP 72-370	Sept. 1	21.3	27.5	2.02	17.0	13.8	4168
	Oct. 3	25.1	27.3	2.04	16.7	13.4	4763
	Nov. 2	21.6	23.0	2.05	17.0	13.6	4166
CP 74-383	Sept. 1	25.6	31.1	2.15	17.5	14.4	5265
	Oct. 3	25.9	31.4	2.12	16.4	12.9	4687
	Nov. 2	24.5	27.7	2.18	16.5	13.0	4483
CP 76-331	Sept. 1	23.7	27.1	2.16	17.7	14.2	4769
	Oct. 3	22.9	25.1	2.26	17.2	13.6	4418
	Nov. 2	22.2	22.8	2.20	16.7	13.1	4074
LSD .05 Treatments		4.2	5.0	0.26	0.9	1.1	845
		Mean Planting Date Effect					
	Sept. 1	23.5	28.2	2.14	17.5	14.3	4782
	Oct. 3	24.5	27.4	2.19	17.0	13.6	4736
	Nov. 2	21.2	22.1	2.16	17.0	13.6	4048
LSD .05 Means		2.1	2.5	NS	0.4	0.6	423

Table 3. Effect of date of harvest on the yield of four varieties of plant cane on Commerce soil at the St. Gabriel Research Station, 1990.

Variety of cane	Date of plant cane harvest	Plant cane yield	Stalk		Normal juice		Sugar yield
			No.	Wt.	Brix	Sucrose	
	1990	T/A	1000/A	lbs.	%	%	lbs/A
CP 70-321	Oct. 1	31.2	30.5	2.30	17.1	13.9	6140
	Nov. 1	30.2	29.0	2.42	18.8	15.8	6921
	Dec. 1	33.5	30.2	2.54	18.4	15.5	7519
CP 72-370	Oct. 1	37.5	33.2	2.28	17.1	13.8	7340
	Nov. 1	36.0	33.2	2.10	18.3	15.1	7856
	Dec. 1	38.6	34.2	2.59	17.6	15.3	8591
CP 79-318	Oct. 1	38.6	28.0	3.46	16.7	13.6	7443
	Nov. 1	36.5	25.6	3.59	17.0	14.1	7346
	Dec. 1	38.9	26.1	3.74	17.8	14.9	8342
LCP 82-89	Oct. 1	44.7	38.0	2.45	17.1	13.5	8542
	Nov. 1	43.6	37.3	2.90	18.0	14.5	9045
	Dec. 1	44.8	37.9	2.83	17.5	14.5	9245
LSD .05 Treatments		4.8	3.1	0.41	0.8	1.0	1450
		Mean Harvest Date Effect					
	Oct. 1	38.0	32.4	2.62	17.0	13.7	7366
	Nov. 1	36.6	31.3	2.75	18.0	14.9	7792
	Dec. 1	38.9	32.1	2.92	17.8	15.1	8424
LSD .05 Means		NS	NS	0.21	0.4	0.5	725

The plant cane of each variety was harvested on four dates and the yields were measured on the last three harvest dates in 1990.

Table 4. Effect of stubble protection after three harvest dates of two cane varieties on the yield of the subsequent stubble crop at the St. Gabriel Research Station, 1990.

Date of plant cane harvest	Stubble protection treatment	Stubble yield 1990	Stalk		Normal juice		Sugar yield
			No.	Wt.	Brix	Sucrose	
1989	1989	T/A	1000/A	lbs.	%	%	lbs/A
			CP 70-321				
Oct. 1	Check	16.6	18.1	2.5	15.1	11.5	2613
	Cover 1	33.5	32.2	2.6	17.1	14.0	6672
	Cover 2	25.3	24.7	2.3	16.4	13.2	4676
Nov. 1	Check	3.1	4.4	2.2	16.7	13.3	602
	Cover 1	28.0	28.8	2.4	17.5	14.4	5790
	Cover 2	23.5	25.2	2.4	17.5	14.4	4851
Dec. 1	Check	5.5	6.5	2.3	17.2	13.8	1068
	Cover 1	31.1	31.2	2.6	17.7	14.5	6434
	Cover 2	30.4	30.2	2.5	17.6	14.4	6286
			CP 72-370				
Oct. 1	Check	20.5	23.9	2.2	15.6	12.2	3466
	Cover 1	29.7	34.3	2.2	17.5	14.3	6060
	Cover 2	25.2	29.3	1.9	16.3	12.9	4533
Nov. 1	Check	6.1	7.2	2.0	16.3	13.1	1115
	Cover 1	24.2	29.5	1.7	17.5	14.3	4924
	Cover 2	24.1	28.5	1.9	17.2	13.9	4757
Dec. 1	Check	10.1	10.4	2.0	17.6	14.2	2040
	Cover 1	25.7	31.7	1.8	17.6	14.5	5321
	Cover 2	26.4	31.4	2.0	17.8	14.4	5433
LSD .05 Treatments		3.6	4.7	0.3	0.3	1.1	762
			Mean Cover Effect				
	Check	10.3	11.8	2.2	16.4	13.0	1817
	Cover 1	28.7	31.3	2.2	17.5	14.3	5867
	Cover 2	25.8	28.2	2.2	17.1	13.9	5089
LSD .05 Means		1.5	1.9	NS	0.4	0.5	311

Cane stubbles were covered after harvesting plant cane. Cover 1 was applied immediately after each harvest date and Cover 2 was applied at the end of the harvest season in December, 1989. The cover was removed with a shaver in March, 1990.

Table 5. Mean effects of Kleen-Tek seedcane, soil pesticides and stubble protection on the yield of first stubble cane on an Iberia clay soil at the Iberia Research Station, 1990.

Variety of cane	Soil pesticide	Soil cover	Stubble Cane yield	Stalk		Juice		Sugar yield
				No.	Wt.	Brix	Sucrose	
			T/A	1000/A	lbs.	%	%	lbs/A
CP 72-370			29.8	29.2	2.07	16.4	12.7	5260
CP 72-370KT			36.2	32.1	2.11	16.3	12.5	6292
LSD .05			2.1	1.7	NS	NS	NS	402
	Check		33.4	31.0	2.03	16.5	12.8	5965
	Ridomil		32.2	31.2	2.10	16.4	12.6	5634
	Furadan		34.1	31.4	2.19	16.2	12.4	5893
	Rido. + Furadan		32.2	29.1	2.02	16.3	12.6	5613
	LSD .05		NS	NS	NS	NS	NS	NS
		Check	31.7	28.7	2.13	16.3	12.5	5428
		Cover	34.8	32.7	2.04	16.4	12.6	6124
		LSD .05	2.1	1.7	NS	NS	NS	402

Kleen-Tek (KT) and "field run" seed of CP 72-370 was planted for the test in 1988. Furadan was applied at planting time and in the spring and Ridomil was applied only in the spring of 1989 and 1990. Application rates were 10 lbs./A Furadan and one pint/A Ridomil. A normal fertilizer rate was applied to all plots and the cane was harvested in November, 1989 and 1990.

This test was conducted in cooperation with Dr. Howard Viator at the Iberia Research Station.

Table 6. Effect of a stubble digger and Lilliston cultivator on the stubble yield of two varieties of sugarcane on a Commerce silt loam soil at the St. Gabriel Research Station, 1990.

Cane variety	Digger Lilliston treatment	Stubble Cane yield	Stalk		Normal juice		Sugar yield
			No.	Wt.	Brix	Sucrose	
		T/A	1000/A	lbs.	%	%	lbs/A
CP 72-370 1st stubble	Check	32.4	30.3	2.18	16.8	13.5	6186
	Digger	38.0	33.3	2.21	16.7	13.5	7244
	Lilliston	37.6	30.0	2.45	17.0	13.6	7246
LSD .05		1.7	NS	NS	NS	NS	918
CP 65-357 2nd stubble	Check	25.1	23.7	2.18	16.3	12.9	4567
	Digger	30.1	26.5	2.16	16.1	12.6	5307
	Lilliston	27.9	26.2	2.24	16.2	12.7	4950
LSD .05		NS	NS	NS	NS	NS	NS
				Means effect			
	Check	28.8	27.0	2.18	16.5	13.2	5377
	Digger	34.0	29.8	2.17	16.4	13.1	6276
	Lilliston	32.7	27.5	2.34	16.6	13.2	6098
LSD .05 Means		3.2	NS	0.13	NS	NS	796

The stubble digger and cultivator treatments were applied after false shaving the cane stubbles on March 9, 1990.

MANAGING FOR STUBBLE LONGEVITY WITH KLEENTEK AND FIELD-RUN CP 72-370 (First Stubble Response)

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Introduction:

The benefits of stubble longevity are obvious, considering the high cost of planting. Successful stubble crops help spread the high cost of fallow activities, seedbed preparation and planting, estimated by the LSU Agricultural Economics Department to be as high as $460 per acre, when planting seed propagated from cultured seed. Although the adverse effects of our relatively severe winter temperatures and high rainfall amounts during the cool season are mostly uncontrollable, other options such as time of harvesting and planting, proper varietal selection, and control of pests are manageable. Furthermore, other good stubbling practices include the minimization of compaction through subsoiling, promotion of drainage by properly preparing seedbeds, proper timing of off-barring and stubble shaving when appropriate and perhaps other useful cultural practices. Identifying the genetic, cultural and chemical options to help avoid stubble burnout should be high on the research agenda. Several researchers are investigating different methods and approaches to enhancing stubble yields and number of stubble crops. The objective of this investigation is to measure the response through the cane cycle of both Kleentek and field-run CP 72-370 to all possible combinations of winter soil cover, Furadan and Ridomil.

Procedures:

On September 21, 1988, forty-eight plots of CP 72-370 were planted. Management factors selected include Ridomil vs. no Ridomil, Furadan vs. no Furadan, winter soil cover vs. no winter soil cover and CP 72-370 Kleentek vs. field-run CP 72-370. The design used was a split-plot, with Ridomil treatments as main plots and other factor combinations factorially arranged on the subplots. Three replicates of all possible treatment combinations were utilized. Furadan was applied in-furrow at planting and in the off-bar each spring at the rate of 10 lbs of formulated material per acre. Ridomil, at 1 pint per acre of formulated material, was applied with liquid fertilizer each May. Millable stalk population counts were made and certain plots were evaluated for RSD and SCMV

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infection. Cane was harvested mechanically and weighed with a tractor-mounted hydraulic scale. Juice quality and stalk weight were determined using fifteen stalk samples randomly selected from each plot. After harvest certain plots were covered with three inches of soil to provide winter protection for stubble pieces. Data recorded for yield and its components were subjected to appropriate analyses of variance.

Results:

Cane and Sugar Yields

Statistical analysis of the data revealed significant treatment effects for soil cover and source of CP 72-370 seed. As shown in the figure on the next page, both Kleentek and soil cover dramatically affected sugar per acre yields. Tonnage was also significantly higher for plots having Kleentek and soil cover (table 1). A significantly higher millable stalk count accounted for the Kleentek and soil cover advantages. Also, a RSD infection level of 36% for the field-run plots probably reduced cane yields during a growing season characterized by abnormally dry conditions during spring and early summer. Furadan and Ridomil were not effective in influencing cane growth or yield. None of the treatment variables influenced the parameters of juice quality, sucrose, purity and CRS. However, there was a tendency for Ridomil to be implicated in juice quality reductions, just as in plant cane last year. Laboratory assay of Pythium populations conducted by Dr. Jeff Hoy did not reveal a feeder root necrosis problem with the soil used in this study.

Stubble Management
First Stubble CP 72-370

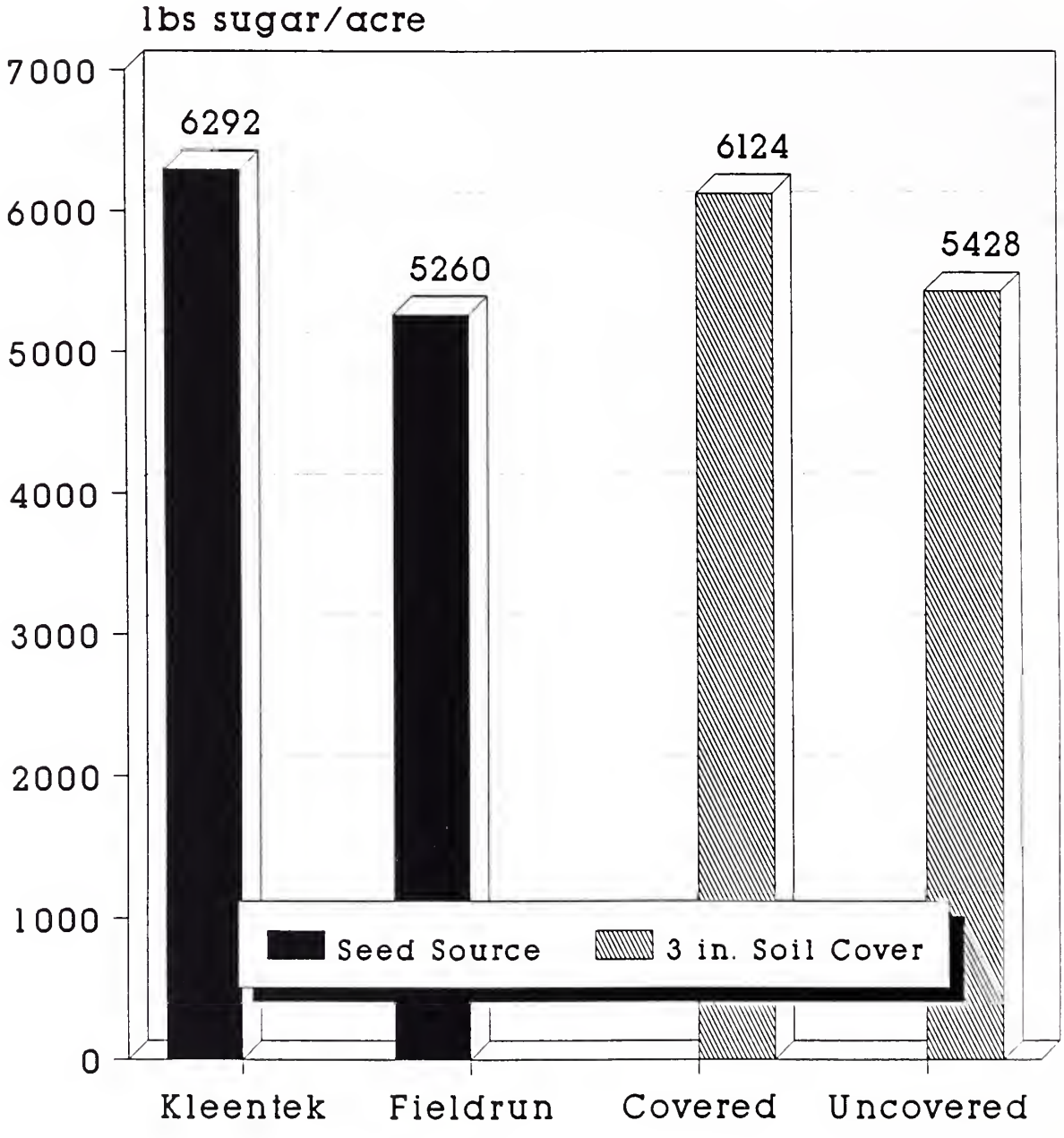

Table 1. Cane tonnage and disease ratings of CP 72-370 in stubble longevity study.

Treatment	First stubble yield	Disease Ratings	
		RSD	SCMV
	tons/acre	% of stalks infected	
Kleentek CP 72-370	36.2	0.0	12.7
Field-run CP 72-370	29.8	36.6	12.6
Soil Cover	34.8	---	---
No Soil Cover	31.2	---	---
Ridomil	32.2	---	---
No Ridomil	33.7	---	---
Furadan	33.1	---	---
No Furadan	32.8	---	---
LSD .05 1/	2.1	---	---

1/ The LSD at the .05 level implies a probability of 5% or less that the difference between seed source and soil cover treatment means was a result of chance.

EVALUATION OF COVER AND CASH CROPS IN FALLOWED SUGARCANE FIELDS
(Preliminary Report of Progress)

Howard P. Viator, William Hallmark,
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Iberia Research Station

Introduction:

With the advent of relatively inexpensive nitrogen fertilizer, conventional wisdom concluded that the benefits of rotations involving legumes were largely associated with nitrogen. As a consequence of nitrogen fertilizer being convenient and economical, rotations between sugarcane and legume crops were mostly abandoned. However, the benefits of green manure rotations have never been adequately quantified. Limited data are available on the benefits and disadvantages of legume/sugarcane rotations. Furthermore, economic analysis of such rotations involving the fallow year have not been comprehensive. The objectives of this investigation were to quantify the benefits and measure the influence on soil properties of legume cover and cash crops grown during the fallow year of the cane cycle.

Experimental Procedures:

Hairy vetch was seeded at 30 pounds per acre on October 27, 1989 after inoculation with appropriate N-fixing bacteria. The seed was planted on sugarcane rows using two drills spaced 18 inches apart. Soil was sampled for organic matter content by compositing twelve randomly selected 6-in. deep cores from each plot. On April 24, 1990 biomass samples (2'x 6') were harvested from the hairy vetch plots for nitrogen content determination by near infrared (NIR) spectroscopy at the Forage Quality Evaluation Laboratory in Franklinton, LA. Group III and IV (Pioneer brand 9391 and Asgrow 4595, respectively) soybeans were seeded on April 10, 1990 and sprayed with a tank mix of 1 1/2 pints of Dual and 2/3 pounds of Lexone per acre. The fallow control plots also received the preemergence application of Dual + Lexone. Hairy vetch was flailed and incorporated in the rows on April 25, 1990. Planted on May 16, 1990 were a Group VII (Hartz 7126) soybean on plots which previously had hairy vetch and a Group IV (Asgrow 4595) soybean on plots which were fallowed since row establishment in the fall. All soybean plantings were accomplished using an IH air-seeder with planting units spaced 18 inches apart, using a planting rate of 6-8 seed per foot of row. Preemergence herbicides were the same as for the April 10 planting. Plot size chosen was three rows, each 52 ft. long.

Research was partially supported by the American Sugar Cane League

In spite of an attempt to incorporate the flailed hairy vetch with row-choppers, some of the residue remained unincorporated and adversely affected seed germination of the Group VII soybean. Germination of seed was satisfactory for the Group IV soybean planted on the same date on a mellowed seedbed. The poor stand which resulted from seeding in plots containing exposed hairy vetch residue was exacerbated by marginal soil moisture.

Benlate fungicide was applied on July 2, 1990, at the rate of 3/4 lb of formulated material per acre to protect all plots scheduled for bean harvest. Cover crop plots were not sprayed with Benlate. At early leaf drop, the early and late planted soybean treatments were sampled for nitrogen content measurement on July 17 and August 20, 1990, respectively. The April planted Group III and Group IV soybeans were harvested for bean yields on August 17, 1990. LCP 82-89 sugarcane was planted on all plots on October 7, 1990 and will be grown through the cycle of stubble crops in order to measure the benefits derived from the previously imposed cover and cash crop treatments. Cane grown on the plots receiving the previous treatments (fallow, cover and cash crops) will be fertilized with both a full and half complement of recommended nitrogen fertilizer each crop year to indirectly estimate the nitrogen credit attributable to each treatment. Soil organic matter changes will be monitored throughout the duration of the experiment.

The amounts of inorganic nitrogen added and the organic nitrogen indirectly measured from the legume crops will be reconciled with the total amount of nitrogen removed from and left in the field during cane harvesting.

Results:

Biomass Yields

The vetch plots had excellent growth and produced an average 3670 pounds of dry matter per acre when flailed and incorporated in the soil on April 24, 1990. The biomass production of the two summer grown cover crop treatments (only the Group IV soybean variety was harvested for dry matter yields) at time of incorporation was 4,820 and 6,186 pounds of dry matter per acre, respectively, for the April and May planted soybeans. The disparity in dry matter production between the same variety of soybeans planted a month apart was primarily a consequence of soil moisture deficits occurring during most of April and May. The May planted soybeans received much more favorable rainfall amounts and distribution. The role that photoperiod response plays in influencing growth and yield of indeterminate-growth-habit soybeans planted at different dates is not known for certain. It is known that they are not as sensitive to the length of the day as are the Group V through VII varieties traditionally grown in the southeast.

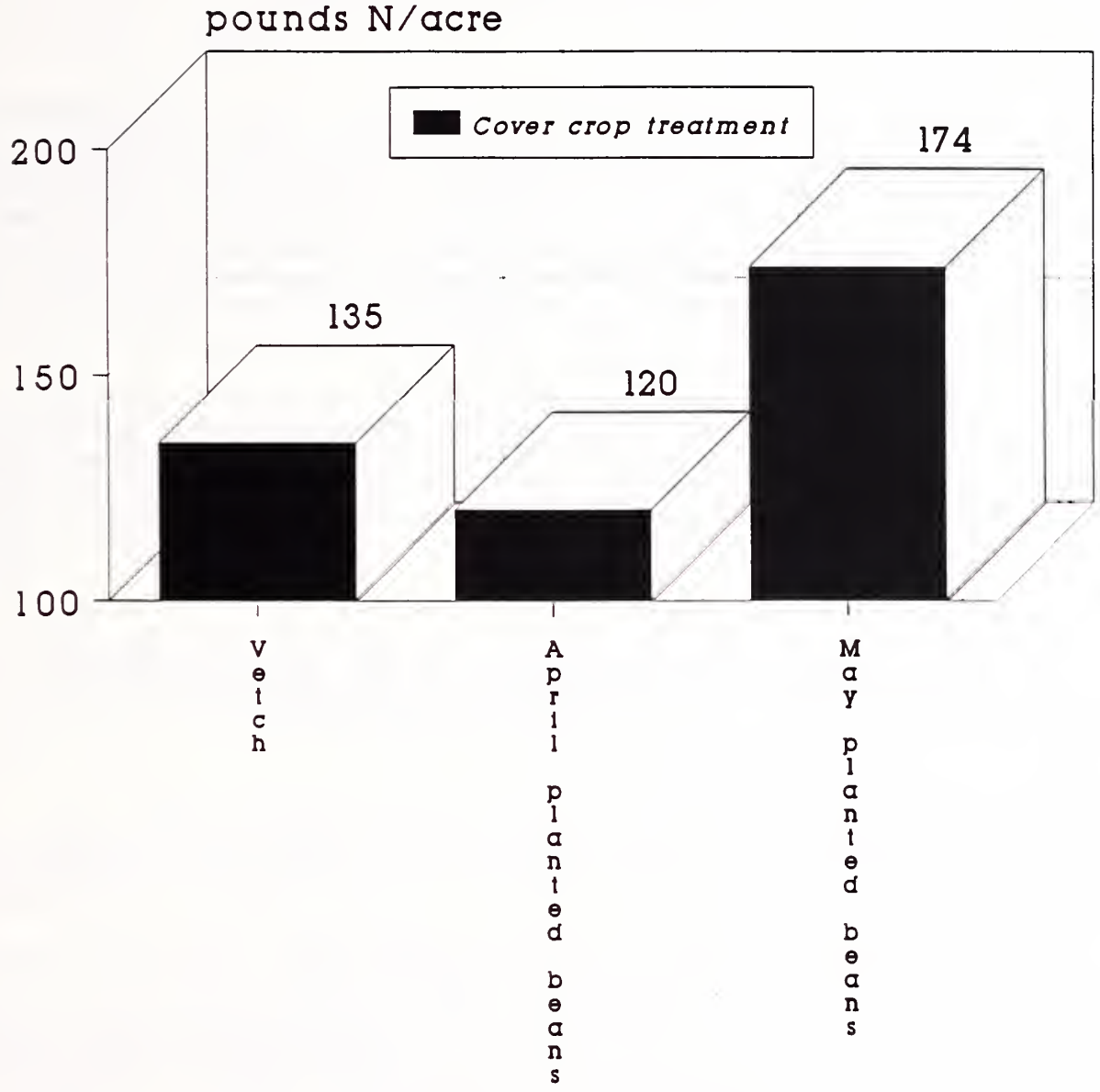
Measured Above-Ground Nitrogen

The bar graph on the next page shows the average per acre measurement of organic nitrogen in the above-ground growth of the legume cover crops. These estimates were based on eight replicates of each legume cover treatment. Nitrogen per acre is the product of multiplying percent nitrogen times dry matter yields. Although not measured in this investigation, others have estimated the nitrogen of the crown and below-ground parts of legumes to be about 30% of the above-ground plant parts. How much, if any, of this soil incorporated organic nitrogen can be used as a fertilizer credit for substitution of purchased nitrogen fertilizer is uncertain at this point in time. Considering the high cost of fallow activities and seedbed preparation, perhaps the occupation of the fallow land by cover crops can minimize the number of fallow plowings and herbicide usage, which would accrue substantial savings. The analysis of costs associated with the production of cover crops is now being undertaken and will be reported at a later date.

Group III and IV Seed Yields

Both the Pioneer brand 9391 Group III and Asgrow 4595 Group IV varieties yielded 31.0 bushels per acre. Yields were strongly affected by the previously alluded to soil moisture shortage which affected the biomass yields. These yields are relatively low and are not indicative of optimum yield potential of early to mid April planted indeterminate varieties. In another experiment planted at the same time as this cover and cash crop investigation, certain soybean varieties produced over 43 bushels per acre. Additionally, five soybean varieties in the Group IV variety evaluation test yielded over 40 bushels per acre when planted in mid-April. Potential exist for fallow-year soybean production of Group III and Group IV varieties to generate returns significantly above costs.

Cover Crop Nitrogen
Above-ground Estimates



SWEET SORGHUM RESEARCH ON BIOMASS AND SUGAR PRODUCTION IN 1990

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in Cooperation with
St. Gabriel Research Station

Summary

An experiment was conducted in 1990 to test the effects of varieties and fertilizer rates on the yield of sweet sorghum. The varieties tested were Wray, M81E and Cowley and the fertilizer treatments were 0-0-0, 90-0-0, 180-0-0, 180-0-80 and 180-0-160 in pounds/A of N, P_2O_5 and K_2O. The stalk and biomass yields were highest in M81E and lowest in the Cowley variety. The percent sucrose and total sugars were similar in Wray and Cowley, but higher than in M81E. The total sugars and alcohol yields per acre were highest in Wray and lowest in M81E.

The stalk yields were increased with 90 lbs./A of N and 80 lbs./A of potash. The total sugar and alcohol yields were increased with 90 lbs./A of N, but not with potash. Higher rates of fertilizers did not significantly increase yield. However, the highest sugar yield per acre was produced in the Wray variety with a 180-0-80 fertilizer.

Objectives

The research was conducted to evaluate the potential of growing sweet sorghum as a biomass and sugar fermentation feedstock for the production of fuel alcohol in Louisiana.

Results and Discussion

An experiment conducted in 1990 consisted of a variety x fertilizer rate test on a Commerce silt loam soil on the St. Gabriel Research Station.

The varieties planted in the test were Wray, M81E and Cowley. The fertilizer treatments were 0-0-0, 90-0-0, 180-0-0, 180-0-80 and 80-0-160 in pounds/A of N, P_2O_5 and K_2O. The sorghum plots were planted in April and each variety was harvested at its mature stage during August and September. The plots were planted in two drills, 22 inches apart on rows spaced six feet apart. The plant spacing was three plants per foot in each drill. The plots were three rows wide and 50 feet long with three replications of each treatment. This method of planting was chosen to accommodate sugarcane harvesting equipment. The fertilizer treatments were bedded in the rows prior to planting. Atrazine was used as a preemergence herbicide and Guthion was used to control sugarcane borers. Furadan was applied at planting time to control lesser corn borers.

The plant population and yield of stalks, leaves and tops were measured at harvest time of each variety. Also, the percent brix or total sugar solids and sucrose in the sorghum juice and percent fiber in the stalks were measured at harvest time. The brix and sucrose were determined with a refractometer and polariscope, respectively. The total fermentable sugars were calculated from a predetermined relationship between liquid chromatograph analyses for total sugars and brix analyses expressed by the equation % total sugars = % Brix - .70. The alcohol yield was calculated from the theoretical conversion of .07 gallon of alcohol per pound of fermentable sugar.

Biomass Yield

The data obtained on biomass yield are reported as factorial mean effects in Table 1. The plant population was adjusted to a uniform stand in early spring, but the Cowley variety had a tendency to have less stalk population and more stalk weight than the other varieties. Cowley has less stooling ability than the Wray and M81E varieties. Each fertilizer treatment increased the stalk weight, but not the stalk population.

The percent fiber in the millable stalks ranged from 13.5% in Wray to 16.8% in Cowley and was not affected by the fertilizer treatments. The net stalk yield was higher in M81E (20.8 T/A) and lower in Cowley (17.4 T/A) than in the Wray variety. The stalk yield was increased with 90 and 180 lbs./A of N over the check plot. Also, potash at 80 lbs./A increased stalk yield over N alone.

The percent leaves on the stalks ranged from 8.4% in M81E to 11.7% in Cowley. The percent tops and seed heads ranged rom 4.0% in Wray to 6.5% in Cowley. The N fertilizer produced larger stalks with a lower percent of leaves and a higher stalk yield than the check plot.

The total biomass which included the stalks, leaves and tops was highest in M81E and lowest in Cowley. The biomass yield was increased with each N rate. The increase with 80 lbs./A of potash was close to significance.

The results show that the M81E variety fertilized with a 180-0-80 fertilizer produced the highest stalk and biomass yield.

Sugar and Alcohol Yield

The mean effects of varieties and fertilizers on the sugar and alcohol yield are reported in Table 2. The brix, sucrose and total sugars in the sorghum juice are expressed as percent of stalk weight and not as percent of extracted juice. The percent of each sugar component in the stalks was highest in Wray and lowest in M81E. Wray and Cowley are similar in sugar content and early maturing sugar varieties. M81E is a late maturing biomass variety.

The sugar and alcohol yields per acre were similar in Wray and Cowley and higher than in the M81E variety.

Each fertilizer treatment produced more sucrose and total sugars than the check plot. The sugar and alcohol yields per acre were increased with 90 lbs./A of N, but increases from a high N rate and from potash were not significant.

Table 1. Mean effect of varieties and fertilizers on the biomass yield of sweet sorghum on Commerce silt loam soil, 1990.

Sweet Sorghum Variety	Fertilizer $N-P_2O_5-K_2O$ lbs/A	Stalk No. 1000/A	Stalk Wt. lbs	Stalk fiber %	Stalk fiber T/A	Stalk yield %	Stalk yield T/A	Leaves yield %	Leaves yield T/A	Tops yield %	Tops yield T/A	Total yield T/A
Wray		40.5	1.01	13.5	2.6	84.7	19.1	11.4	2.5	4.0	0.9	22.4
M81E		42.1	1.05	14.4	2.9	85.1	20.8	8.4	1.8	6.4	1.6	24.2
Cowley		36.7	1.14	16.8	2.9	81.9	17.4	11.7	2.3	6.5	1.4	21.0
	0-0-0	38.4	0.54	15.8	1.3	78.8	8.6	15.9	1.7	5.3	0.6	10.9
	90-0-0	38.3	1.21	14.5	3.0	85.1	21.1	9.3	2.3	5.6	1.4	24.8
	180-0-0	41.1	1.14	15.0	3.1	84.8	20.9	9.1	2.2	6.0	1.5	24.6
	180-0-80	39.9	1.31	14.3	3.3	85.2	23.2	9.1	2.5	5.7	1.6	27.2
	180-0-160	40.9	1.13	15.0	3.2	85.5	21.6	8.9	2.2	5.5	1.4	25.1
HSD .05	Variety	2.1	0.13	0.7	0.2	1.3	1.5	1.2	0.3	0.8	0.2	1.8
HSD .05	Fertilizer	NS	0.20	1.0	0.4	1.9	2.3	1.8	0.5	NS	0.3	2.8

Table 2. Mean effect of varieties and rates of fertilizer on the sugar and alcohol yield of sweet sorghum on a Commerce silt loam soil on the St. Gabriel Research Station, 1990.

Sweet Sorghum Variety	Fertilizer $N-P_2O_5-K_2O$ lbs/A	Sugar yield in stalks at maturity					Alcohol yield gal/A
		Brix %	Sucrose %	Sucrose lbs/A	Total sugars %	Total sugars lbs/A	
Wray		17.0	13.3	5106	16.3	6276	439
M81E		11.8	8.9	3719	11.4	4607	327
Cowley		16.8	12.9	4581	16.2	5713	400
	0-0-0	14.5	10.8	1870	14.0	2421	170
	90-0-0	15.1	11.4	4776	14.6	6005	427
	180-0-0	15.8	12.3	5082	15.2	6256	438
	180-0-80	15.3	12.0	5504	14.8	6788	475
	180-0-160	15.2	12.0	5111	14.6	6188	433
HSD .05 Variety		0.7	0.9	587	0.7	542	40
HSD .05 Fertilizer		1.0	1.4	892	1.0	824	61

Sugar content expressed as percent of stalk weight.

SUGARCANE RESEARCH REPORT FOR 1990

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Department of Agricultural Economics and Agribusiness

Farm cost and return projections for Louisiana sugarcane enterprises have been published in the present format for ten years. However, the presentation has undergone considerable change in an effort to provide meaningful information to farmers, extension personnel, researchers, lending agencies and others working in agriculture and/or agribusiness timely planning information.

Detailed production sequences and associated costs for 1991 are presented for six activity sets, an overhead budget and projected revenues in The Department of Agricultural Economics and Agribusiness A.E.A. INFORMATION SERIES NOS. 87-93. The activities include fallow, seedbed preparation, cutting and planting seedcane, cultural regimes for plant cane, first stubble and second stubble crops, harvesting sugarcane with one and two row harvesters with alternative hauling options and heat treatment to control RSD. All cost and revenue estimates are calculated on a per acre of land basis. This format affords each individual an opportunity to select those budgets that fit his "unique" situation and develop cost and return estimates reflecting his land situation and production activities.

The late December freeze in 1989 had a disastrous impact on the 1990 sugarcane crop in Louisiana and will influence future crops until a normal rotational cycle can be reestablished. Projected output per rotational acre and its distribution between the grower and suppliers of land and milling services are presented in Tables 1-6 for 1989 and prior years, and 1990 through 1994. The magnitude of the change emanating from the 1989 freeze in the distribution of plant and stubble cane and fallow within a rotational acre not only affects output but also cost.

Table 7 summarizes projected cost and return per rotational acre for 1989 through 1994. The destabilizing impact of the 1989 freeze on income in future years is clearly shown and will create a major problem in 1994 unless growers reduce the fallow portion of each rotational acre. Currently, growers have two options in dealing with this problem; retaining some third stubble and or succession planting. Table 8 provides a rotational acre cost and yield projection for a third ratoon regime. This option addresses the devastating impact of fallowing more than 25 percent of each rotational acre. Productivity per rotational acre would increase 22 percent while cost declines 8 percent when compared with the normal scheme shown in Table 6. A similar scheme could be used in 1995 to not only eliminate the cyclical impact of the 1989 freeze but also modify the rotation to further reduce the fallow component.

Succession planting could be used in conjunction with the third ratoon regime to affect a more cost effective rotational package. However, sufficient detailed input/output data is not currently available to carry out a reliable analysis.

Table 1. Normal Output per Rotational Acre for Tenants and Owner Operators, Sugar Cane, Louisiana, 1989 and Prior Years.

Item	Land Use %	Plant Cane		1st Stubble		2nd Stubble		Marketable Output per Rotational Acre
		Tenant	Owner/Operator	Tenant	Owner/Operator	Tenant	Owner/Operator	
Land	100	5600	5600	4800	4800	4200	4200	
Harvested Rotational Cane								
Plant Cane	.25	1400	1400	-0-	-0-	-0-	-0-	
1st Stubble	.25	-0-	-0-	1200	1200	-0-	-0-	
2nd Stubble	.25	-0-	-0-	-0-	-0-	1050	1050	
Amount for Seed*	.05	70	70	-0-	-0-	-0-	-0-	
Fallow	.25							
Raw Sugar		1330	1330	1200	1200	1050	1050	
Mill	.39	519	519	468	468	410	410	
Land Rent	.12	160	-0-	144	-0-	126	-0-	
Grower's Share**								
Tenant		651	-0-	588	-0-	514	-0-	1753
Owner/Operator		-0-	811	-0-	732	-0-	640	2184

* Comes out of plant cane.

** Grower share is raw sugar less amount taken out for mill and rent.

Table 2. Projected Output per Rotational Acre for Tenants and Owner Operators, Sugar Cane, Louisiana, 1990.

Item	Land Use %	Plant Cane		1st Stubble		2nd Stubble		Marketable Output per Rotational Acre
		Tenant	Owner/Operator	Tenant	Owner/Operator	Tenant	Owner/Operator	
Land	100	4480	4480	3600	3600	2200	2200	
Harvested Rotational Cane								
Plant Cane	.25	1120	1120	-0-	-0-	-0-	-0-	
1st Stubble	.25	-0-	-0-	900	900	-0-	-0-	
2nd Stubble	.05	-0-	-0-	-0-	-0-	110	110	
Amount for Seed*	.09	101	101	-0-	-0-	-0-	-0-	
Fallow	.45							
Raw Sugar		1019	1019	900	900	110	110	
Mill	.39	397	397	351	351	43	43	
Land Rent	.12	75	-0-	108	-0-	13	-0-	
Grower's Share**								
Tenant		547	-0-	441	-0-	54	-0-	1042
Owner/Operator		-0-	622	-0-	549	-0-	67	1238

* Comes out of plant cane.

** Grower share is raw sugar less amount taken out for mill and rent.

Table 3. Projected Output per Rotational Acre Estimates for Tenants and Owner Operators, Sugar Cane, Louisiana, 1991.

Item	Land Use %	Plant Cane		1st Stubble		2nd Stubble		Marketable Output per Rotational Acre
		Tenant	Owner/Operator	Tenant	Owner/Operator	Tenant	Owner/Operator	
Land	100	5600	5600	4800	4800	4200	4200	
Harvested Rotational Cane								
Plant Cane	.39	2184	1747	-0-	-0-	-0-	-0-	
1st Stubble	.20	-0-	-0-	960	768	-0-	-0-	
2nd Stubble	.10	-0-	-0-	-0-	-0-	420	420	
Amount for Seed*	.062	135	108	-0-	-0-	-0-	-0-	
Fallow	.31							
Raw Sugar		2049	2049	960	960	420	420	
Mill	.39	799	799	374	374	164	164	
Land Rent	.12	250	-0-	117	-0-	51	-0-	
Grower's Share**								
Tenant		1000	-0-	468	-0-	205	-0-	1673
Owner/Operator		-0-	1250	-0-	586	-0-	256	2092

* Comes out of plant cane.

** Grower share is raw sugar less amount taken out for mill and rent.

Table 4. Projected Output per Rotational Acre Estimates for Tenants and Owner Operators, Sugar Cane, Louisiana, 1992.

Item	Land Use %	Plant Cane		1st Stubble		2nd Stubble		Marketable Output per Rotational Acre
		Tenant	Owner/Operator	Tenant	Owner/Operator	Tenant	Owner/Operator	
Land	100	5600	5600	4800	4800	4200	4200	
Harvested Rotational Cane								
Plant Cane	.31	1736	1736	-0-	-0-	-0-	-0-	
1st Stubble	.39	-0-	-0-	1872	1872	-0-	-0-	
2nd Stubble	.20	-0-	-0-	-0-	-0-	840	840	
Amount for Seed*	.02	35	35	-0-	-0-	-0-	-0-	
Fallow	.10	-0-	-0-	-0-	-0-	-0-	-0-	
Raw Sugar		1701	1701	1872	1872	840	840	
Mill	.39	663	663	730	730	328	328	
Land Rent	.12	125	-0-	225	-0-	101	-0-	
Grower's Share**								
Tenant		913	-0-	917	-0-	411	-0-	2241
Owner/Operator		-0-	1038	-0-	1142	-0-	512	2692

* Comes out of plant cane.

** Grower share is raw sugar less amount taken out for mill and rent.

Table 5. Projected Output per Rotational Acre Estimates for Tenants and Owner Operators, Sugar Cane, Louisiana, 1993.

Item	Land Use %	Plant Cane		1st Stubble		2nd Stubble		Marketable Output per Rotational Acre
		Tenant	Owner/Operator	Tenant	Owner/Operator	Tenant	Owner/Operator	
Land	100	5600	5600	4800	4800	4200	4200	
Harvested Rotational Cane								
Plant Cane	.10	560	560	-0-	-0-	-0-	-0-	
1st Stubble	.31	-0-	-0-	1488	1488	-0-	-0-	
2nd Stubble	.39	-0-	-0-	-0-	-0-	1638	1638	
Amount for Seed*	.04	22	22	-0-	-0-	-0-	-0-	
Fallow	.20	-0-	-0-	-0-	-0-	-0-	-0-	
Raw Sugar		538	538	1488	1488	1638	1638	
Mill	.39	210	210	580	580	639	639	
Land Rent	.12	39	-0-	109	-0-	120	-0-	
Grower's Share**								
Tenant		289	-0-	799	-0-	879	-0-	1967
Owner/Operator		-0-	328	-0-	908	-0-	999	2235

* Comes out of plant cane.

** Grower share is raw sugar less amount taken out for mill and rent.

Table 6. Projected Output per Rotational Acre Estimates for Tenants and Owner Operators, Sugar Cane, Louisiana, 1994.

Item	Land Use %	Plant Cane		1st Stubble		2nd Stubble		Marketable Output per Rotational Acre
		Tenant	Owner/Operator	Tenant	Owner/Operator	Tenant	Owner/Operator	
Land	100	5600	5600	4800	4800	4200	4200	
Harvested Rotational Cane								
Plant Cane	.20	1120	1120	-0-	-0-	-0-	-0-	
1st Stubble	.10	-0-	-0-	480	480	-0-	-0-	
2nd Stubble	.31	-0-	-0-	-0-	-0-	1302	1302	
Amount for Seed*	.078	87	87	-0-	-0-	-0-	-0-	
Fallow	.39	-0-	-0-	-0-	-0-	-0-	-0-	
Raw Sugar		1033	1033	480	480	1302	1302	
Mill	.39	403	403	187	187	508	508	
Land Rent	.12	76	-0-	35	-0-	95	-0-	
Grower's Share**								
Tenant		554	-0-	258	-0-	699	-0-	1511
Owner/Operator		-0-	630	-0-	293	-0-	794	1717

* Comes out of plant cane.

** Grower share is raw sugar less amount taken out for mill and rent.

Table 7. Projected Costs and Returns per Rotational Acre of Land in Sugarcane, Sandy Soils, Tenant Operators, River Region, Louisiana.

Year	Adjusted Yield Per Acre lbs	Total Income	Total Direct Costs	Returns Above Direct Costs	Total Fixed Costs	Total Specified Costs	Returns Above Specified Costs	Overhead Costs	Residual Returns	Cost per Unit of Output
1989	1753	372.48	187.92	184.56	76.40	264.32	108.16	52.66	55.50	.181
1990	1042	227.00	166.24	60.78	71.16	237.40	-10.38	49.55	-59.93	.275
1991	1673	383.21	297.55	85.66	76.52	374.07	9.14	53.48	-44.34	.256
1992	2241	488.19	222.14	266.05	68.91	291.05	197.14	53.48	143.66	.154
1993	1967	428.50	266.84	161.66	72.90	339.74	88.76	53.48	35.28	.200
1994	1511	329.16	291.77	37.39	76.37	368.14	-38.98	53.48	-92.46	.279
1994*	1851	403.23	267.66	135.57	72.49	340.15	63.08	53.48	9.60	.213

* Plant and 3 ratoon option.

Table 8. Projected Output per Rotational Acre for Tenants and Owner Operators, Plantcane and 3 Ratoon Harvests, 1994.

Item	Land Use %	Plant Cane		1st Stubble		2nd Stubble		3rd Stubble		
		Tenant	Owner/Operator	Tenant	Owner/Operator	Tenant	Owner/Operator	Tenant	Owner/Operator	
Land	100	5600	5600	4800	4800	4200	4200	3600	3600	
Harvested Rotational Cane										
Plant Cane	20	1120	1120	-0-	-0-	-0-	-0-	-0-	-0-	
1st Stubble	10	-0-	-0-	480	480	-0-	-0-	-0-	-0-	
2nd Stubble	31	-0-	-0-	-0-	-0-	1302	1302	-0-	-0-	
3rd Stubble	19	-0-	-0-	-0-	-0-	-0-	-0-	684	684	
Amount for Seed*	04	45	45	-0-	-0-	-0-	-0-	-0-	-0-	
Fallow	20			-0-	-0-	-0-	-0-	-0-	-0-	
Raw Sugar		1075	1075	480	480	1302	1302	684	684	
Mill	.39	419	419	187	187	508	508	267	267	
Land Rent	.12	129	-0-	35	-0-	95	-0-	50	-0-	
Grower's Share**										
Tenant		527		258		699		367		1851
Owner/Operator			656		293		794		417	2160

* Comes out of plant cane.

** Grower share is raw sugar less amount taken out for mill and rent.

PUBLICATIONS AND PRESENTATIONS

Appachu, N., M. Saska, and D. F. Day. 1990. "Aqueous two phase extraction of dextransucrase" AICHE Annual Meeting, Chicago, IL Nov. 11-16, 1990.

Bengtson, R. L. and C. E. Carter. 1990. Simulating soil erosion in the lower Mississippi valley with the CREAMS model. In Application of Water Quality Models for Agricultural and Forested Watersheds. Southern Cooperative Series Bulletin No. 338. pp 93-97.

Berding, N., G.A. Brotherton, D.G. LeBrock, J.C. Skinner. 1989. Application of NIR spectroscopy to the analysis of sugar cane in clonal evaluation trials. Proceedings of the Australian Society of Sugarcane Technologists:124-127.

Bessin, R. T. and R. T. Reagan. 1990. Fecundity of the sugarcane borer (Lepidoptera: Pyralidae), as affected by larval development on gramineous host plants. Environmental Entomology 19:635-639.

Bessin, R. T., T. E. Reagan and F. A. Martin. 1990. A moth production index for evaluating sugarcane cultivars for J. Economic Entomology 83:221-225.

Bessin, R. T., T. E. Reagan and E. B. Moser. 1990. Integration of control tactics for management of the sugarcane borer (Lepidoptera: Pyralidae) in Louisiana sugarcane. J. Economic Entomology 83:1563-1569.

Bessin, R. T., E. B. Moser, T. E. Reagan, and W. H. White. 1990. Analysis of percent bored internode data collected from sugarcane borer varietal resistance evaluations. J. American Society of Sugar Cane Technologists 10:8-22.

Bessin, R. T., R. E. Stinner and T. E. Reagan. 1991. Modeling the areawide impact of sugarcane varieties and predation on sugarcane borer (Lepidoptera: Pryralidae) populations in Southern Louisiana. Environmental Entomology 20:252-257.

Bischoff, K. P., S. B. Milligan and F. A. Martin. 1990. Performance of the sugarcane variety LCP82-089 in replicated yield trials in Louisiana. Sugar y Azucar. June. p 26.

Breithaupt, J.A., A. Arceneaux, and R. Ricaud. 1990. Effects of by-product gypsum on soil properties, nutrient content and yield of sugarcane. Jour. Am. Soc. of Sugarcane Tech. Vol. 10 (in press).

Carter, Cade E., B. Halverson, J. S. Rogers, and M. Musgrave. 1990. Effects of excess soil water on sweet corn yield. Trans. of the ASAE 33(4):1203-1207.

Carter, Cade E., J. L. Fouss, and J. S. Rogers. 1990. Sugarcane response to subsurface drainage in 1989: a progress report. Louisiana Agricultural Experiment Station's Sugarcane Research Annual Progress Report, pp 5-13.

Carter, Cade E., R. L. Bengtson, J. L. Fouss, and J. S. Rogers. 1990. Benefits of subsurface draining land for sugarcane. Abstract. Sugar y Azucar 85(6)35.

Chang, Y. S. and S. B. Milligan. 1990. The effect of intrarow spacing and the utility of best linear unbiased predictors in sugarcane cross appraisal. Sugar y Azucar. June. p 26-27.

Chang, Y. S. and S. B. Milligan. 1990. The effect of intrarow spacing and the utility of best linear unbiased predictors in sugarcane cross appraisal. p 84. Agronomy Abstracts. (poster).

Chao, C. P., J. W. Hoy, A. M. Saxton, and F. A. Martin. 1990. Heritability of resistance and repeatability of clone reactions to sugarcane smut in Louisiana. Phytopathology 80:622-626.

Chen, W., J. W. Hoy, and R. W. Schneider. 1990. Variation observed in ribosomal DNA of Pythium spp. agrees with isozymes analysis. (Abstr). Phytopathology 80:964.

Christy, R. D., B. A. Chapman, and A M. Heagler. 1990. Structural Change and Economic Efficiency Within Louisiana's Sugarcane Processing Industry. DAE Research Report No. 685, Department of Agricultural Economics and Agribusiness, Louisiana Agricultural Experiment Station, Louisiana State University Agricultural Center, Baton Rouge, Louisiana , September 1990.

Damann, K. E. and C. A. Hollier. 1991. Distribution and incidence of ratoon stunting disease in Louisiana sugarcane. Plant Disease 75:000-000.

Damann, K. 1990. Effect of sugarcane cultivar susceptibility on spread of ratoon stunting disease by the mechanical harvester. Phytopathology 80:1001.

Damann, K. E. 1990. Apparent mating between Ustilago scitaminea and Sporisorium reilianum. Proceedings of the Seventh Biennial Workshop on Smut Fungi, p17.

Day, D. F.. 1990. Dextranase- A summary. ASSCT, LA Branch, Baton Rouge, LA Feb 6-7.

Day, D. F.. 199X. Spoilage in the Sugar Industry. **IN** The Lactic Acid Bacteria. Vol 1. Elsevier Press.

Day, D. F. and M. L. Marceau-Day. 199X. The use of dye binding to monitor polysaccharide production in *Pseudomonas aeruginosa*. ENZYME ENGINEERING X, Annals of the New York Academy of Sciences, Submitted.

Garrison, D. D., K. L. Quebedeaux, H. L. Waguespack, and W. R. Jackson. 1990. Sugarcane variety outfield experiments in Louisiana during 1989. Sugar Bulletin, Vol 1, Oct. 1990.

Gravois, K. A. and S. B. Milligan. 1990. Genetic relationships between fiber and sugarcane yield components. Agronomy Abstracts. p 90.

Gravois, K. A., S. B. Milligan and F. A. Martin. 1990. Role of pith, tube and stalk density in determining sugarcane sucrose content and stalk weight. Theor. Appl. Gent. 79: 273-277.

Griffin, J.L. and L.M. Kitchen. 1990. Evaluation of preemergence and postemergence herbicides for sugarcane tolerance. J. Am. Soc. Sugarcane Technol. 10:61-65.

Griffin, J.L., B.J. Hook, R.S. Peregoy, and L.M. Kitchen. 1990. Emergence and yield of 2,4-D treated seed cane. J. Am. Soc. Sugarcane Technol. 10:56-60.

Griffin, J.L., R.J. Lencse, and E.P. Richard, Jr. 1990. Itchgrass control in sugarcane with postemergence herbicides. Proc. South. Weed Sci. Soc. 43:85.

Griffin, J.L. and R.J. Lencse. 1990. Comparisons of preemergence herbicides for itchgrass control and sugarcane injury. Am. Soc. Sugarcane Technol. Mtg. June 14, 1990. Lake Buena Vista, FL.

Hallmark, W. B., and D. L. Anderson. 1990. Effect of plant growth stage on sugarcane nutrient diagnoses. (Abstract). Page 270, American Society of Agronomy Annual Meeting. October, 1990. San Antonio, TX.

Heagler, A. M. 1991. Projected costs and returns. AEA Information Series No. 91, Department of Agricultural Economics and Agribusiness, Louisiana Agricultural Experiment Station, Louisiana State University Agricultural Center, Baton Rouge, Louisiana, January 1991.

Hoy, J. W., and C. P. Chao. 1990. Repeatability of sugarcane clone smut reactions in Louisiana. J. Amer. Soc. Sugar Cane Technol. 10:115.

Hoy, J. W., L. B. Grelen, and Y,. S. Lee. 1990. Sugarcane smut and Pythium root rot research. Pages 65-67, in : Sugarcane Research Annual Progress Report 1989. La. Agricultural Exp. Sta. Publication. pp 282.

Lee, Y. S., J. W. Hoy. 1990. Effects of Pythium species on the growth of sugarcane in pathogenicity tests and field soil. (Abstr.) Phytopathology 80: 121.

Lencse, R.J., J.L. Griffin, and E.P. Richard, Jr. 1990. Itchgrass interference in sugacane. Proc. South. Weed Sci. Soc. 43:341.

Kim, D. and D. F. Day. 1990. Multiple dextranase isozymes of *Lipomyces starkeyi*. 90th Annual Meeting, American Society for Microbiology, Anaheim, CA 13-17th May, 1990.

Marceau-Day, M. L., C. A. Day, D. F. Day, and G. M. Day. 1990. A simple method for visualizing alginate slimes produced by *Pseudomonas Aeruginosa*. 90th Annual Meeting, American Society of Microbiology, Anaheim, CA 13-17 May, 1990.

McDonald, L. M. and S. B. Milligan. 1990. Methods to control environmental heterogeneity in unreplicated testing in the Louisiana sugarcane variety development program. Sugar y Azucar. June. p 26.

McDonald, L. M and S. B. Milligan. 1990. Methods to control environmental heterogeneity in unreplicated testing in the Louisiana sugarcane variety development program. p 100. Agronomy Abstracts. (poster).

Milligan, S. B., K. A. Gravois, K. P. Bischoff and F. A. Martin. 1990. Crop effects on broad-sense heritabilities and genetic variances of sugarcane yield components. Crop Sci. 30: 344-349.

Milligan, S. B., K. A. Gravois, K. P. Bischoff and F. A. Martin. 1990. Crop effects on genetic relationships among sugarcane traits. Crop Sci. 30: 927-931.

Milligan, S. B. Evaluation of methods to control environmental variation in unreplicated test plots. p 19. In M.S. Kang (ed.) Genotype by environment interaction and plant breeding symp. Poster paper abstr. Baton Rouge, LA. 12-13 Feb. 1990.

Milligan, S. B. and B. L. Legendre. 1990. Cross by location interaction in sugarcane cross appraisal. Sugar y Azucar. June. p 24-26.

Milligan, S. B. and B. L. Legendre. 1990. Cross by location interaction in sugarcane cross appraisal. p 101. Agronomy Abstracts. (poster).

Navarre, D. A. and K. E. Damann. 1990. Synthesis of indole-3-acetic acid by Ustilago maydis. Phytopathology 80:1055.

Navarre, D. A. and K. E. Damann. 1990. Phytohormone production and auxin biosynthesis by Ustilago maydis. Proc. of the Seventh Biennial Workshop on Smut Fungi, p 7.

Ogunwolu, E. O., T. E. Reagan and S. D. Hensley. 1991. Effects of Diatraea saccharalis (F.) (Lepidoptera: Pyralidae) damage and stalk rot fungi on sugarcane yield in Louisiana. Crop Protection 10:57-61.

Reagan, T. E. and R. T. Bessin. 1990. Differential instantaneous rates of increase of the sugarcane borer, Diatraea saccharalis (F.) on 2 sugarcane varieties. Proceedings International Society of Sugar Cane Technologists 20 (vol. 2):823-828.

Ricaud, R. and A. Arceneaux. 1990. Succession cane in Louisiana. Sugar Bull., Vol. 69, No. 2, p. 14-22.

Ricaud, R. and A. Arceneaux. 1990. Cultural practices and soil fertility for sugarcane. Sugarcane Research, Progress Report, LAES for 1989. p. 14-26 and 31-40.

Ricaud, R. Soil Fertility, Iberville Parish meeting, St. Gabriel Station, Feb., 1990.

Ricaud, R. Stubble protection and succession Cane, Research-Extension meeting, St. Gabriel, May 1990.

Ricaud, R. Stubble diggers and protection, American Sugar Cane League Contact meeting, Thibodaux, July, 1990.

Ricaud, R. Stubble protection, LSU Area Field Day, St. Gabriel, July, 1990.

Ricaud, R. Succession cane, Iberia Parish Field Day, Jeanerette, July, 1990.

Ricaud, R. Succession cane, St. James Parish Field Day, St. James, August, 1990.

Ricaud, R. Stubble longevity, Agent Training meeting, St. Gabriel, Sept., 1990.

Ricaud, R. Subsoiling and stubble protection, Research-Extension meeting, Houma, Jan., 1991.

Ricaud, R. Factors affecting stubble longevity, ASSCT annual meeting, Baton Rouge, Feb., 1991.

Richard, E.P., Jr. and J.L. Griffin. 1990. Postemergence johnsongrass control in sugarcane. Proc. South. Weed Sci. Soc. 43:87.

Showler, A. T., T. E. Reagan and K. P. Shao. 1990. Nematode interactions with weeds and sugarcane mosaic virus in Louisiana sugarcane. J. Nematology 22:31-38.

Showler, A. T., T. E. Reagan and R. M. Knaus. 1990. Sugarcane weed community interactions with arthropods and pathogens. Insect Science and It's Application 11:1-11.

Showler, A. T., r. M. Knaus and T. E. Reagan. 1990. Studies on the territorial dynamics of the red imported fire ant (Solenopsis invicta Buren, Hymenoptera: Formicidae). J. Agriculture, Ecosystems and Environment 30:97-105.

Showler, A. T. and T. E. Reagan. 1991. Effects of sugarcane borer, weed, and nematode control strategies in Louisiana Sugarcane. Environmental Engomology 20:358-370.

White, C. A., R. T. Bessin and T. E. Reagan. 1990. Insecticide evaluation for wireworm control in sugarcane, 1989. Insecticide and Acaricide Tests 15:292(162F).

White, C. A., R. T. Bessin and T. E. Reagan. 1990. Insecticidal control of the sugarcane borer, 1989. Insecticide and Acaricide Tests 15:272(132F).